



(86) Date de dépôt PCT/PCT Filing Date: 2002/06/06  
(87) Date publication PCT/PCT Publication Date: 2002/12/27  
(45) Date de délivrance/Issue Date: 2010/10/12  
(85) Entrée phase nationale/National Entry: 2003/12/17  
(86) N° demande PCT/PCT Application No.: ES 2002/000274  
(87) N° publication PCT/PCT Publication No.: 2002/102781  
(30) Priorité/Priority: 2001/06/18 (ES P 200101412)

(51) Cl.Int./Int.Cl. *C07D 231/06* (2006.01),  
*C07B 57/00* (2006.01)

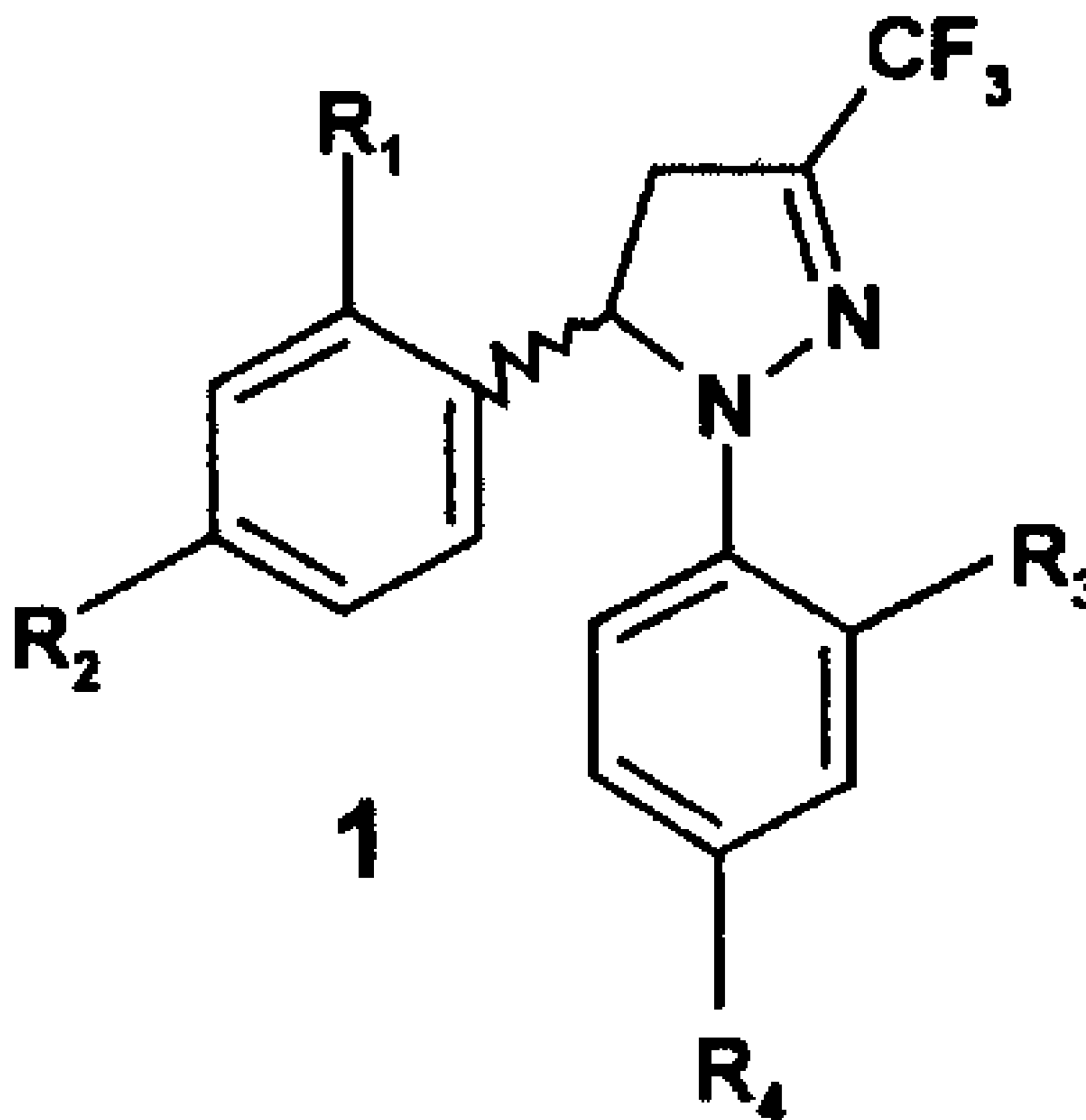
(72) Inventeurs/Inventors:  
ALCON-MARRUGAT, MONTERRAT, ES;  
PERICAS-BRONDO, MIGUEL ANGEL, ES;  
CUBERES-ALTISEN, MARIA ROSA, ES;  
FRIGOLA-CONSTANSA, JORDI, ES

(73) Propriétaire/Owner:  
LABORATORIOS DEL DR. ESTEVE S.A., ES

(74) Agent: FETHERSTONHAUGH & CO.

(54) Titre : PROCEDE DE PREPARATION DE DERIVES DE 1,5-DIARYL-3-TRIFLUOROMETHYL- $\Delta^2$ -PYRAZOLINES  
RACEMIQUES ET PURES DU POINT DE VUE ENANTIOMERIQUE

(54) Title: PROCESS FOR THE PREPARATION OF RACEMIC AND ENANTIOMERICALLY PURE DERIVATIVES OF 1,5-DIARYL-3-TRIFLUOROMETHYL- $\Delta^2$ -PYRAZOLINES



(57) Abrégé/Abstract:

Process for preparation of compounds with the general formula 1, which include the racemic mixtures ( $\pm$ )-1, and the enantiomerically pure compounds (-)-1 and (+)-1, wherein  $R_1$  and  $R_3$ , same or different, represent an atom of hydrogen, chlorine,



**(57) Abrégé(suite)/Abstract(continued):**

fluorine, a methyl, trifluoromethyl or methoxy group;  $R_2$  represents an atom of hydrogen, chlorine, fluorine, a methyl, trifluoromethyl, methoxy, trifluoromethoxy, methylsulphonyl or aminosulphonyl group;  $R_4$  represents an atom of hydrogen, chlorine, fluorine, a methyl, trifluoromethyl, methoxy, trifluoromethoxy, methylsulphonyl or aminosulphonyl group, with the condition that one of the substituents  $R_2$  or  $R_4$  is a methylsulphonyl or aminosulphonyl group; which comprises obtaining the racemic mixture with the general formula  $(\pm)$ -1 by reacting an (E)-1,1,1-trifluoro-4-aryl-3-buten-2-one with a phenylhydrazine, followed by a treatment with chlorosulphonic acid, or by reacting with chlorosulphonic acid followed by a reaction with sodium hydroxide and, finally, with thionyl chloride. The product obtained by either of these methods is made to react with ammonium carbonate or ammonia, or with sodium sulphite and methyl iodide or methyl sulphate. In addition, to obtain the enantiomerically pure compounds with the general formula 1 by resolving the racemic mixture with the general formula  $(\pm)$ -1, a reaction is effected with optically active ephedrine, followed by formation of the sodium salt of each enantiomer, reaction with thionyl chloride and ammonium carbonate or ammonia, or instead with thionyl chloride followed by sodium sulphite and methyl iodide or methyl sulphate to thereby obtain separately the enantiomerically pure compounds with the general formulae  $(-)$ -1 and  $(+)$ -1. (see formula 1)

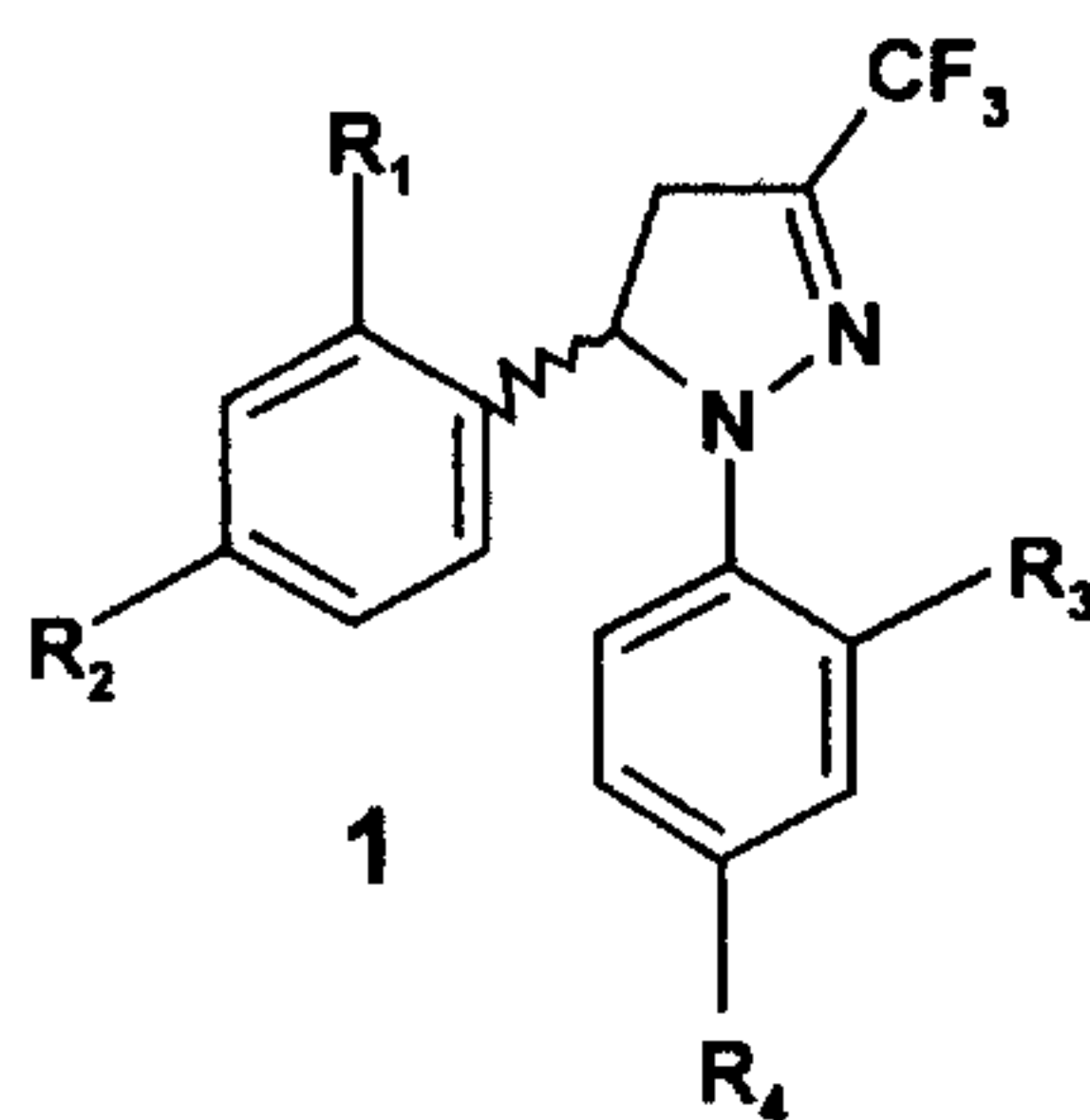
**PROCESS FOR THE PREPARATION OF RACEMIC AND  
ENANTIOMERICALLY PURE DERIVATIVES OF 1,5-DIARYL-3-  
TRIFLUOROMETHYL- $\Delta^2$ -PYRAZOLINES**

5

**ABSTRACT**

Process for preparation of compounds with the general formula **1**, which include the racemic mixtures ( $\pm$ )-**1**, and the enantiomerically pure compounds (-)-**1** and (+)-**1**, wherein  $R_1$  and  $R_3$ , same or different, represent an atom of hydrogen, chlorine, fluorine, a methyl, trifluoromethyl or methoxy group;  $R_2$  represents an atom of hydrogen, chlorine, fluorine, a methyl, trifluoromethyl, methoxy, trifluoromethoxy, methylsulphonyl or aminosulphonyl group;  $R_4$  represents an atom of hydrogen, chlorine, fluorine, a methyl, trifluoromethyl, methoxy, trifluoromethoxy, methylsulphonyl or aminosulphonyl group, with the condition that one of the substituents  $R_2$  or  $R_4$  is a methylsulphonyl or aminosulphonyl group; which comprises obtaining the racemic mixture with the general formula ( $\pm$ )-**1** by reacting an (*E*)-1,1,1-trifluoro-4-aryl-3-buten-2-one with a phenylhydrazine, followed by a treatment with chlorosulphonic acid, or by reacting with chlorosulphonic acid followed by a reaction with sodium hydroxide and, finally, with thionyl chloride. The product obtained by either of these methods is made to react with ammonium carbonate or ammonia, or with sodium sulphite and methyl iodide or methyl sulphate. In addition, to obtain the enantiomerically pure compounds with the general formula **1** by resolving the racemic mixture with the general formula ( $\pm$ )-**1**, a reaction is effected with optically active ephedrine, followed by formation of the sodium salt of each enantiomer, reaction with thionyl chloride and ammonium carbonate or ammonia, or instead with thionyl chloride followed by sodium sulphite and methyl iodide or methyl sulphate to thereby obtain separately the enantiomerically pure compounds with the general formulae (-)-**1** and (+)-**1**.

30



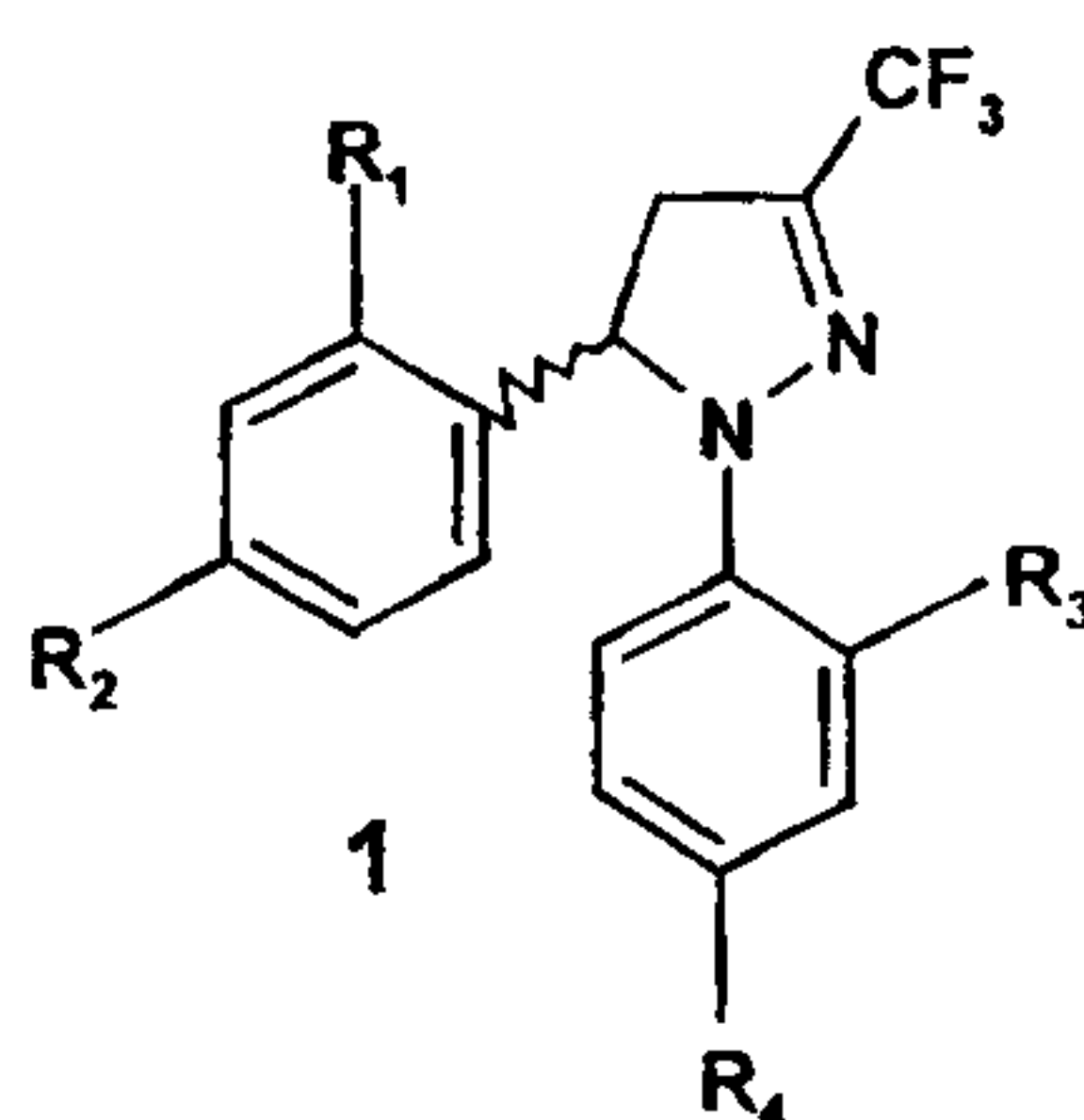
27395-151

1

**PROCESS FOR THE PREPARATION OF RACEMIC AND  
ENANTIOMERICALLY PURE DERIVATIVES OF 1,5-DIARYL-3-  
TRIFLUOROMETHYL- $\Delta^2$ -PYRAZOLINES**

## 5 Field of the Invention

The present invention relates to a new, commercially useful process for the preparation of compounds having the general formula 1, which includes the racemic mixture ( $\pm$ )-1, and the enantiomerically pure compounds (-)-1 and (+)-1.



## Background of the Invention

Our Patent WO 9962884 describes new derivatives of  $\Delta^2$ -pyrazolines, also known as 4,5-dihydro-1*H*-pyrazoles, which inhibit the enzyme cyclooxygenase-2, with application in human and/or veterinary medicine as anti-inflammatories and in other diseases in which cyclooxygenase-2 is involved, and which present a low or zero gastric and renal toxicity, so that they are anti-inflammatories with a greater safety profile. Certain racemic mixtures ( $\pm$ )-1, and the enantiomerically pure stereoisomers (-)-1 and (+)-1 described in said Patent are currently in a clinical investigation stage. The aforementioned Patent describes the preparation of ( $\pm$ )-1 by reaction of (*E*)-1,1,1-trifluoro-4-aryl-3-buten-2-one with 4-(aminosulphonyl)phenylhydrazine or 4-(methylsulphonyl)phenylhydrazine, or by reaction of 4-(aryl)phenylhydrazine with (*E*)-1,1,1-trifluoro-4-(4-aminosulphonylphenyl)-3-buten-2-one or (*E*)-1,1,1-trifluoro-4-(4-methylsulphonylphenyl)-3-buten-2-one. It also describes the production of (-)-1 and (+)-1 by resolution of the racemic mixture ( $\pm$ )-1 using high resolution liquid chromatography with a CHIRALPAK AS<sup>TM</sup> column of de 10 $\mu$  particle size and dimensions 25  $\times$  2 cm (Daicel), mobile phase 0.1% of

diethylamine in methanol and flow rate of 8 ml/min.

In addition, the methods for resolution of racemic mixtures described in the literature are numerous and have been widely used [ a) for a monograph of the properties of racemates and their resolutions see Jacques, Collet, Wilen  
5 "Enantiomers Racemates and Resolutions", Wiley: New York, 1981; for reviews see: b) Wilen, *Top. Stereochem.*, **1971**, 6, 107; c) Boyle, *Q. Rev. Chem. Soc.*, **1971**, 25; d) Buss, Vermeulen, *Ind. Eng. Chem.*, **1968**, 60, 12]. However, there are few examples in the scientific literature regarding resolution of  $\Delta^2$ -  
10 pyrazolines [Toda, *J. Chem. Soc., Chem. Commun.*, **1995**, 1453]. This paper describes the resolution of a  $\Delta^2$ -pyrazoline by formation of an inclusion complex. A prior paper [Mukai, *Can. J. Chem.*, **1979**, 57, 360-366] develops the resolution of an optically active assembly of  $\Delta^2$ -pyrazolines-sodium benzenosulphate from the corresponding racemics, using as resolution agents  
15 cinchonidine, (-)- $\alpha$ -methylbenzylamine and brucine, depending on the substrate. This method has the disadvantage of using successive recrystallisations in both the process of formation of sodium sulphonate (between 3 and 7 recrystallisations), and in the process of formation and separation of the mixture of diastereoisomeric salts (between 4 and 7 recrystallisations), which results in  
20 a considerable reduction of the yield.

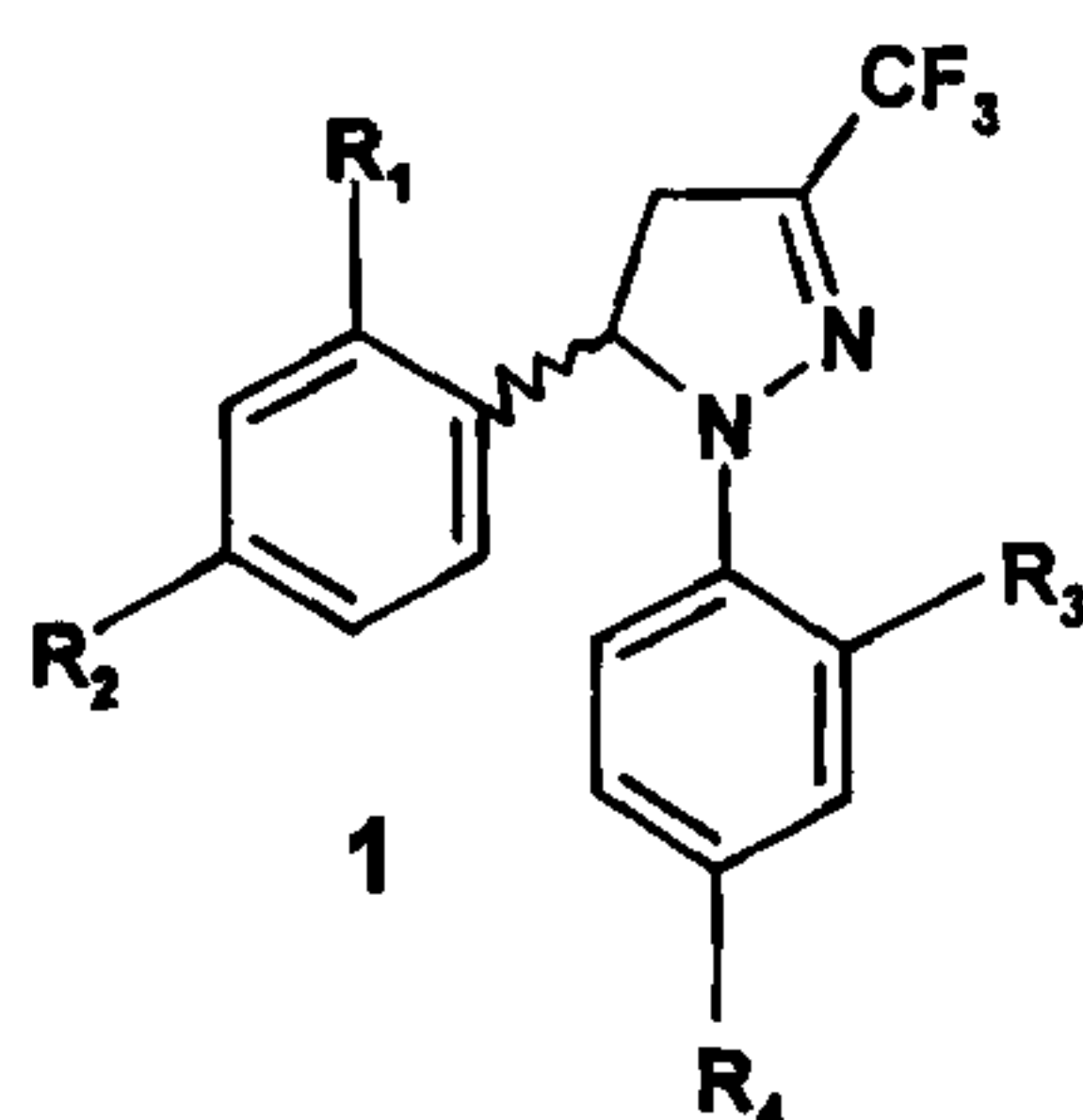
We have now found a strategy for preparing compounds with the general formula 1 which consists of using derivatives of benzaldehyde much cheaper than 4-(aminosulphonyl)benzaldehyde or 4-(methylsulphonyl)benzaldehyde for  
25 obtaining (*E*)-1,1,1-trifluoro-4-aryl-3-buten-2-one, and derivatives of phenylhydrazine much cheaper than 4-(aminosulphonyl)phenylhydrazine or 4-(methylsulphonyl)phenylhydrazine. The enone and hydrazine are used to obtain the ring of  $\Delta^2$ -pyrazoline, which process when sequentially combined with a sulphonation and an optical resolution process to obtain the enantiomerically pure  
30 compounds of the racemic sulphonic acid using an optically active base, or a mixture of bases in which at least one is optically active, leads to the formation of diastereoisomeric salts. The process continues with the separation of these salts, transformation into the sodium salt, formation of the acid chloride and obtaining the enantiomerically pure sulphonamide or sulphone 1.

35

27395-151

2a

According to one aspect of the present invention, there is provided a process for preparing a racemic mixture ( $\pm$ )-1 of compounds having the general formula 1, enantiomerically pure compounds (-)-1 and (+)-1,



wherein

$R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy;

$R_2$  represents hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy, trifluoromethoxy, methylsulphonyl or aminosulphonyl;

$R_4$  represents hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy, trifluoromethoxy, methylsulphonyl or aminosulphonyl;

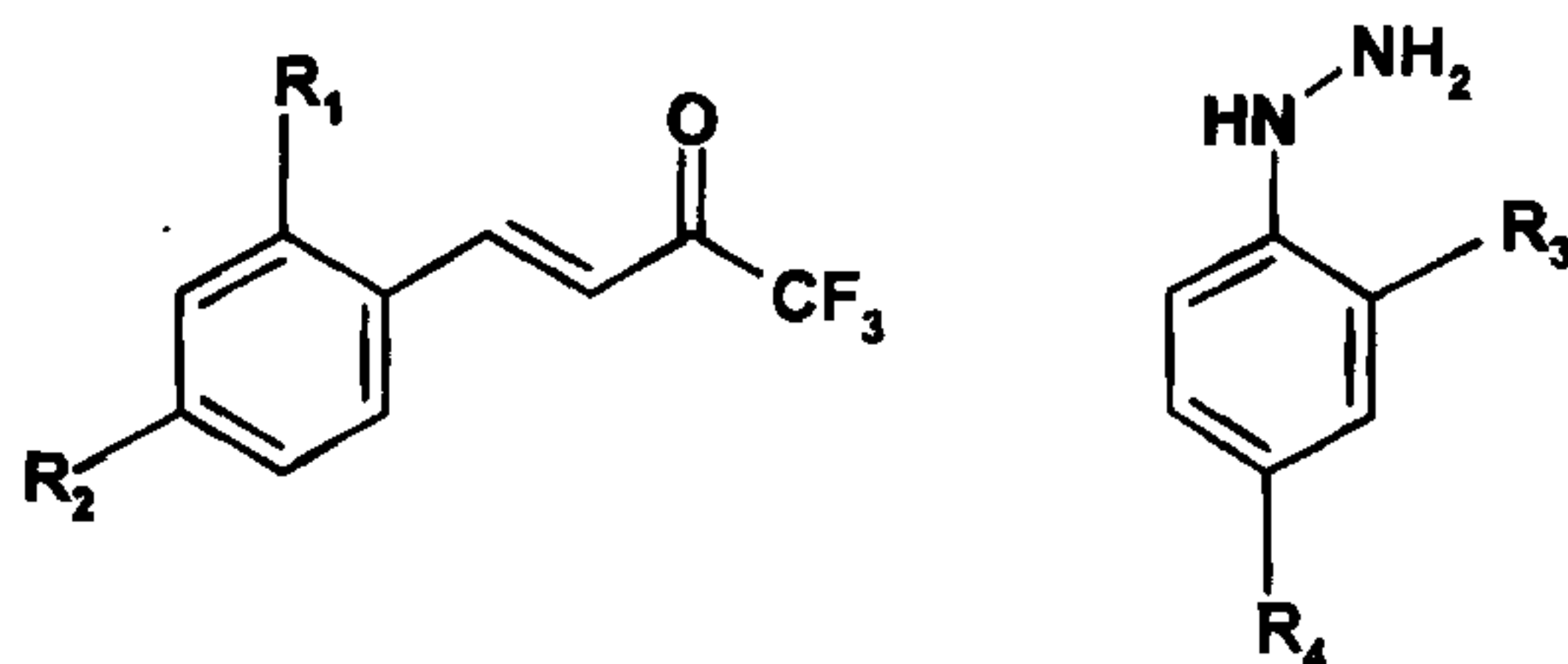
with the proviso that  $R_2$  or  $R_4$  is methylsulphonyl or aminosulphonyl;

wherein the process comprises:

a) preparing the racemic mixture with the general formula ( $\pm$ )-1 by reacting an (*E*)-1,1,1-trifluoro-4-aryl-3-buten-2-one with a phenylhydrazine, wherein  $R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy; and  $R_2$  and  $R_4$  represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy or trifluoromethoxy; with the proviso that at least one of  $R_2$  and  $R_4$  represents hydrogen

27395-151

2b



to obtain a pyrazoline with the general formula ( $\pm$ )-1, wherein  $R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy; and  $R_2$  and  $R_4$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy or trifluoromethoxy; with the proviso that at least one of  $R_2$  and  $R_4$  represents hydrogen;

b) reacting the pyrazoline of a) with chlorosulphonic acid followed by reaction with sodium hydroxide to form the pyrazoline with the general formula ( $\pm$ )-1, wherein  $R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy; and  $R_2$  and  $R_4$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy, trifluoromethoxy or a sodium sulphonate group, with the proviso that one of  $R_2$  and  $R_4$  represents the sodium sulphonate group ( $\text{SO}_3\text{Na}$ );

c) reacting the pyrazoline of b) with thionyl chloride to form the pyrazoline with the general formula ( $\pm$ )-1, wherein  $R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy; and  $R_2$  and  $R_4$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy, trifluoromethoxy or sulphonyl chloride; with the proviso that one of  $R_2$  and  $R_4$  represents a sulphonyl chloride group ( $\text{SO}_2\text{Cl}$ );

d) reacting the pyrazoline of c) with ammonium carbonate or ammonia, or with sodium sulphite and methyl iodide or methyl sulphate to provide the racemic mixture with the general formula ( $\pm$ )-1 wherein  $R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy; and  $R_2$  and  $R_4$  independently represent hydrogen, chlorine, fluorine,

27395-151

## 2c

methyl, trifluoromethyl, methoxy, trifluoromethoxy, methylsulphonyl or aminosulphonyl; with the proviso that one of  $R_2$  and  $R_4$  represents a methylsulphonyl group ( $\text{SO}_2\text{CH}_3$ ) or an aminosulphonyl group ( $\text{SO}_2\text{NH}_2$ ); and

- e) optionally, after completion of step b), preparing the
- 5 enantiomerically pure compounds with the general formula **1** by resolving the racemic mixture of the pyrazoline of b) with the general formula ( $\pm$ )-**1**, into the enantiomers thereof by reaction with optically active ephedrine, followed by formation of the sodium salt of each enantiomer, reaction with thionyl chloride and ammonium carbonate or ammonia, or with thionyl chloride followed by sodium
- 10 sulphite and methyl iodide or methyl sulphate, to obtain separately the enantiomerically pure compounds with the general formula (-)-**1** and (+)-**1** wherein  $R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy; and  $R_2$  and  $R_4$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy, trifluoromethoxy,
- 15 methylsulphonyl or aminosulphonyl; with the proviso that one of  $R_2$  and  $R_4$  represents a methylsulphonyl group ( $\text{SO}_2\text{CH}_3$ ) or an aminosulphonyl group ( $\text{SO}_2\text{NH}_2$ ).

- According to another aspect of the present invention, there is provided a process as described herein, wherein, in step a), the
- 20 (*E*)-1,1,1-trifluoro-4-aryl-3-buten-2-one is reacted with the phenylhydrazine in an alcohol or in absence of a solvent, in an organic acid medium comprising acetic acid or p-toluensulphonic acid or in an inorganic acid comprising hydrochloric acid, or in an alkaline medium provided by piperidine, piperazine, sodium hydroxide, potassium hydroxide, sodium methoxide or sodium ethoxide at a temperature
- 25 ranging between ambient temperature and  $150^\circ\text{C}$  for a time between 2 and 48 hours.

According to still another aspect of the present invention, there is provided a process as described herein, wherein the alcohol is ethanol or isopropanol.

27395-151

## 2d

According to yet another aspect of the present invention, there is provided a process as described herein, wherein, in step b), the pyrazoline with the general formula (±)-1 of a) is reacted with the chlorosulphonic acid without a solvent or with a chlorinated solvent at a temperature between 0°C and 100°C, and afterwards reacting with the sodium hydroxide to form the pyrazoline with the general formula (±)-1 wherein one of R<sub>2</sub> and R<sub>4</sub> represents the sodium sulphonate group (SO<sub>3</sub>Na) and R<sub>1</sub>, R<sub>3</sub> and the other of R<sub>2</sub> and R<sub>4</sub> are as described herein.

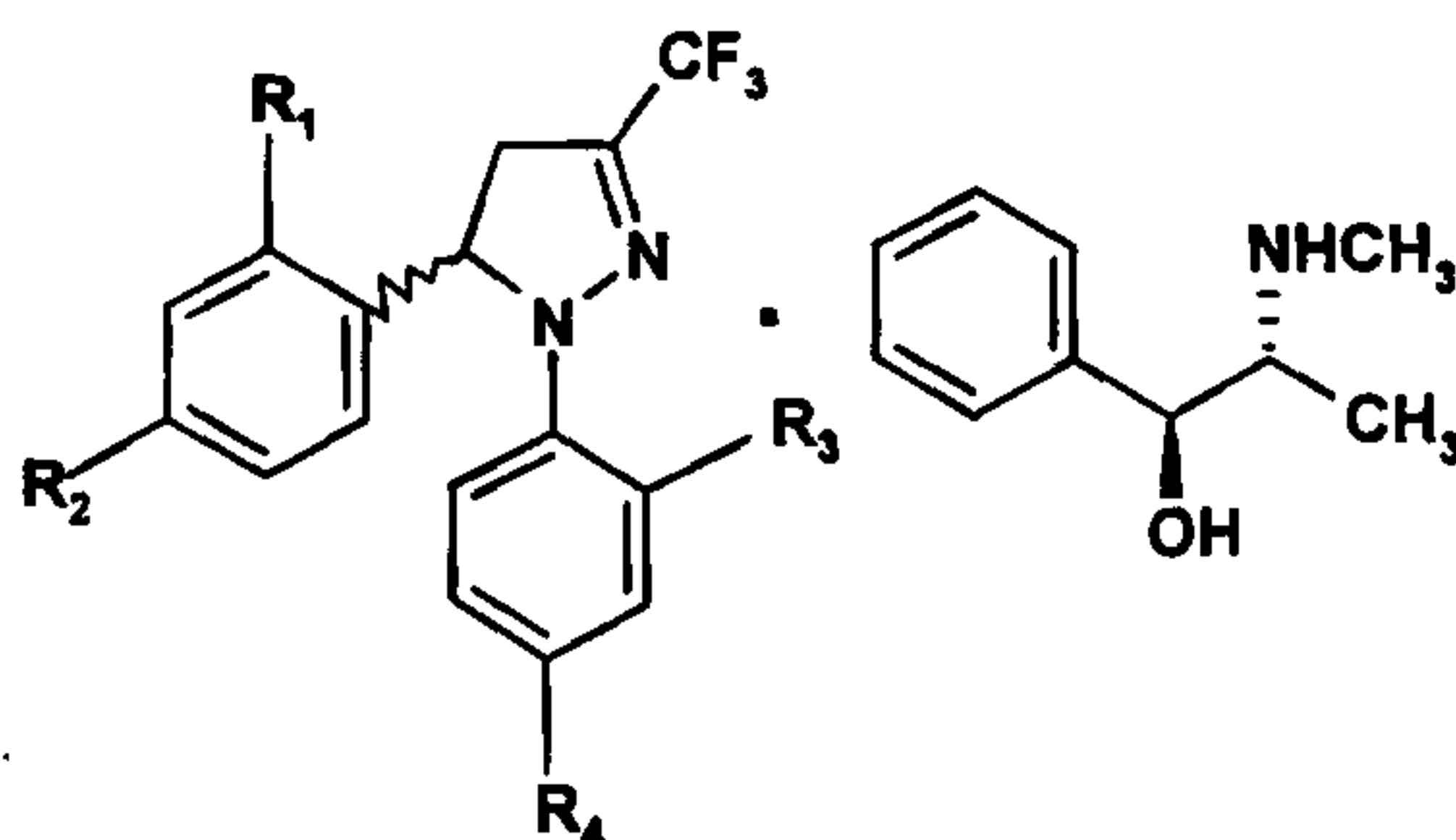
According to a further aspect of the present invention, there is provided a process as described herein, wherein, in step c), the pyrazoline with the general formula (±)-1 of step b), is reacted with the thionyl chloride in a solvent at a temperature between 40°C and reflux temperature for a time between 2 and 24 hours, and then, in step d), the product of step c) is reacted with the ammonium carbonate or the ammonia, or with thionyl chloride followed by the sodium sulphite and the methyl iodide or the methyl sulphate in toluene, methanol or water, at a temperature between 40°C and reflux temperature for a time between 1 and 12 hours, to form the pyrazoline with the general formula (±)-1 wherein one of R<sub>2</sub> and R<sub>4</sub> represents the methylsulphonyl group (SO<sub>2</sub>CH<sub>3</sub>) or the aminosulphonyl group (SO<sub>2</sub>NH<sub>2</sub>) and R<sub>1</sub>, R<sub>3</sub> and the other of R<sub>2</sub> and R<sub>4</sub> are as described herein.

According to yet a further aspect of the present invention, there is provided a process as described herein, wherein the solvent of step c) is toluene.

According to still a further aspect of the present invention, there is provided a process as described herein, wherein the resolution of the racemic mixture (±)-1 of step b), by reaction with the (+)-ephedrine of step e) takes place in a solvent and the separation of the (-)-1 and (+)-1 enantiomers comprises crystallisation of diastereoisomeric salt (-)-1·(+)-ephedrine of (+)-1·(+)-ephedrine, wherein one of R<sub>2</sub> and R<sub>4</sub> represents a sulphonic acid group (SO<sub>3</sub>H) and R<sub>1</sub>, R<sub>3</sub> and the other of R<sub>2</sub> and R<sub>4</sub> are as described herein, and

27395-151

2e



1·(+)-ephedrine

10 separate formation of the sodium salts (-)-**1** and (+)-**1**, in an aqueous medium or  
 an alcohol comprising isopropyl alcohol, wherein one of  $R_2$  and  $R_4$  represents a  
 sodium sulphonate group ( $\text{SO}_3\text{Na}$ ) and the  $R_1$ ,  $R_3$  the other of  $R_2$  and  $R_4$  are as  
 described herein; and then, in step d), reacting each enantiomer with the thionyl  
 15 chloride and then with the ammonium carbonate or the ammonia, or instead with  
 the thionyl chloride followed by the sodium sulphite and the methyl iodide or the  
 methyl sulphate, to form separately the enantiomerically pure pyrazolines (-)-**1** and  
 (+)-**1**, wherein one of  $R_2$  and  $R_4$  represents the methylsulphonyl group ( $\text{SO}_2\text{CH}_3$ )  
 or the aminosulphonyl group ( $\text{SO}_2\text{NH}_2$ ) and  $R_1$ ,  $R_3$  and the other of  $R_2$  and  $R_4$  are  
 as described herein.

20 According to another aspect of the present invention, there is  
 provided a process as described herein, wherein the resolution of the racemic  
 mixture ( $\pm$ )-**1** of step b), by reaction with the (-)-ephedrine of step e) takes place in  
 a solvent and the separation of the (-)-**1** and (+)-**1** enantiomers comprises  
 crystallisation of diastereoisomeric salt (-)-**1**·(-)-ephedrine of (+)-**1**·(-)-ephedrine,  
 25 wherein one of  $R_2$  and  $R_4$  represents a sulphonic acid group ( $\text{SO}_3\text{H}$ ) and  
 $R_1$ ,  $R_3$  and the other of  $R_2$  and  $R_4$  are as described herein, and separate formation  
 of the sodium salts (-)-**1** and (+)-**1**, in an aqueous medium or in an alcohol  
 comprising isopropyl alcohol, wherein one of  $R_2$  and  $R_4$  represents a sodium  
 sulphonate group ( $\text{SO}_3\text{Na}$ ) and  $R_1$ ,  $R_3$  and the other of  $R_2$  and  $R_4$  are as described  
 30 herein, and then, in step d), reacting each enantiomer with the thionyl chloride and

27395-151

2f

then with the ammonium carbonate or the ammonia, or with the thionyl chloride followed by the sodium sulphite and the methyl iodide or the methyl sulphate, to form separately the enantiomerically pure pyrazolines (-)-1 and (+)-1, wherein one of  $R_2$  and  $R_4$  represents the methylsulphonyl group ( $\text{SO}_2\text{CH}_3$ ) or the  
5 aminosulphonyl group ( $\text{SO}_2\text{NH}_2$ ) and  $R_1$ ,  $R_3$  and the other of  $R_2$  and  $R_4$  are as described herein.

According to yet another aspect of the present invention, there is provided a process as described herein, wherein the solvent of step e) is chloroform or toluene.

## Detailed Description of the Invention

The object of the present invention consists of providing a commercially useful process for preparing compounds with the general formula 1, which includes the racemic mixture ( $\pm$ )-1 and the enantiomerically pure compounds (-)-1 and (+)-1, where

$R_1$  and  $R_3$ , identical or different, represent an atom of hydrogen, chlorine, fluorine, a methyl, trifluoromethyl or methoxy group,

10  $R_2$  represents an atom of hydrogen, chlorine, fluorine, a methyl, trifluoromethyl, methoxy, trifluoromethoxy, methylsulphonyl or aminosulphonyl group,

$R_4$  represents an atom of hydrogen, chlorine, fluorine, a methyl, trifluoromethyl, methoxy, trifluoromethoxy, methylsulphonyl or aminosulphonyl  
15 group,

With the proviso that one of the substituents  $R_2$  or  $R_4$  is a methylsulphonyl or aminosulphonyl group.

20 The present invention discloses a method for obtaining the racemic mixture ( $\pm$ )-1 that is less expensive than the one described previously in Patent WO 9962884 as it uses phenylhydrazine instead of 4-(aminosulphonyl)phenylhydrazine or 4-(methylsulphonyl)phenylhydrazine, or benzaldehyde instead of 4-(aminosulphonyl)benzaldehyde or 4-(methylsulphonyl)benzaldehyde to obtain the ring of  $\Delta^2$ -pyrazoline, represented in  
25 the scheme 1 as the compound ( $\pm$ )-2. By means of sulphonation the acid chloride is obtained, which is made to react with ammonia or ammonium carbonate to obtain the sulphonamide ( $R_2$  or  $R_4$  = SO<sub>2</sub>NH<sub>2</sub>), or with sodium sulphite and the sodium sulphinate obtained with methyl sulphate or methyl  
30 iodide to obtain the methylsulphone ( $R_2$  or  $R_4$  = SO<sub>3</sub>CH<sub>3</sub>), ( $\pm$ )-1. It is also possible to isolate the corresponding sodium salt: by sulphonation and treatment with sodium hydroxide the salt ( $\pm$ )-3 is obtained, which is reacted with thionyl chloride and the acid chloride obtained is reacted with ammonia or ammonium carbonate to obtain the sulphonamide ( $R_2$  or  $R_4$  = SO<sub>2</sub>NH<sub>2</sub>), or  
35 instead with sodium sulphite and the sodium sulphinate obtained with methyl

27395-151

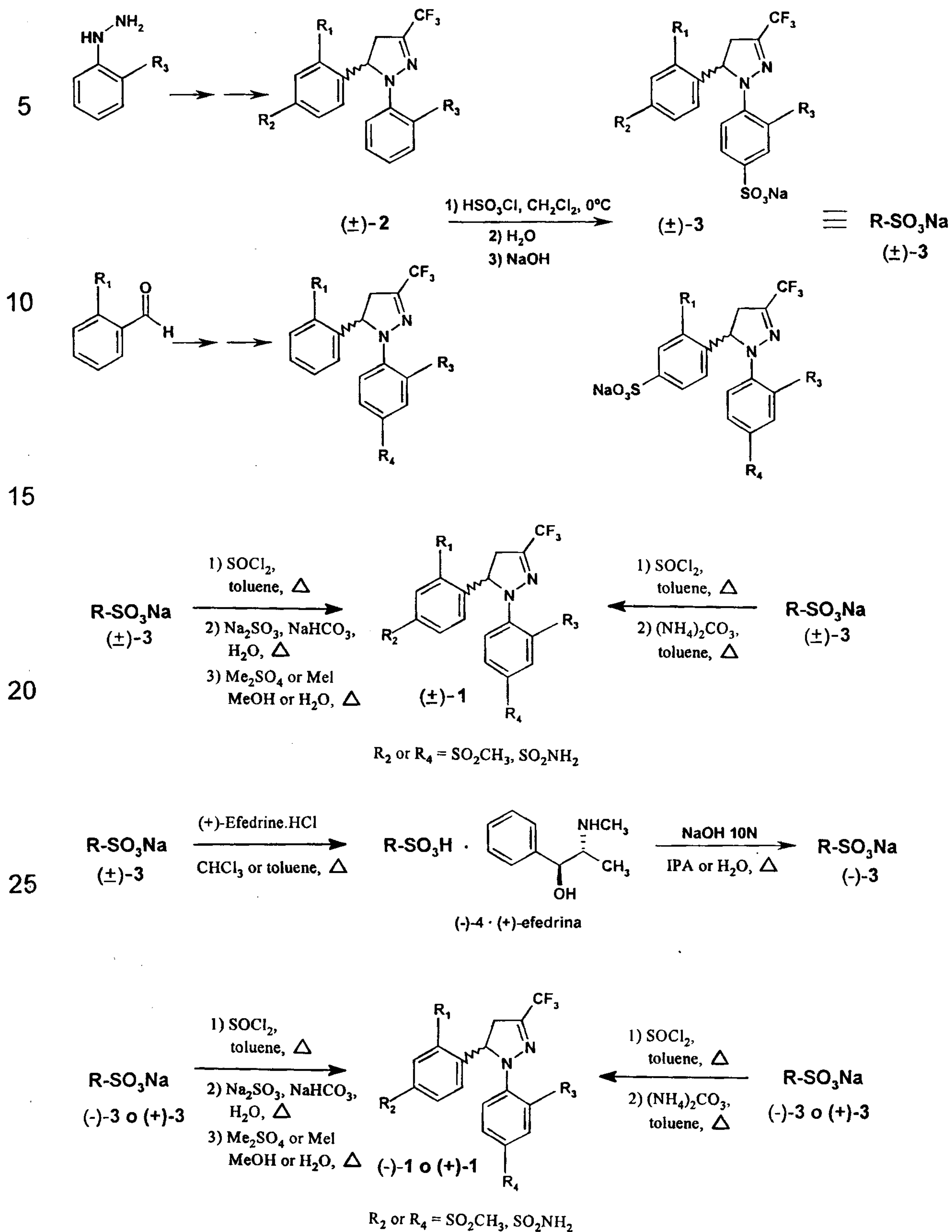
4

sulphate or methyl iodide to obtain the methylsulphone ( $R_2$  or  $R_4 = SO_2CH_3$ ), ( $\pm$ )-1.

It also provides an industrial application method for obtaining the enantiomerically pure stereoisomers (+)-1 and (-)-1. One pair of enantiomers  
5 can be resolved by various methods, with conversion to diastereoisomeric salts and their separation by fractioned crystallisation being the most commonly used. Once the diastereoisomeric salts have been obtained and separated the enantiomers (acids or bases) can be easily liberated, and the chiral acid or base recovered, so that this simple and inexpensive method has been widely used  
10 for industrial applications. If the racemic compound contains an amine group in its structure it is possible to form diastereoisomeric salts with an optically active acid, and if the racemic compound contains an acid group it is possible to form diastereoisomeric salts with an optically active base. Since the compound 1 lacks any acid or basic groups strong enough to form diastereoisomeric salts  
15 the present invention develops a process which is described schematically below (Reaction Scheme 1) for obtaining the racemic mixture ( $\pm$ )-1 and the enantiomerically pure compounds (-)-1 and (+)-1.

27395-151

5

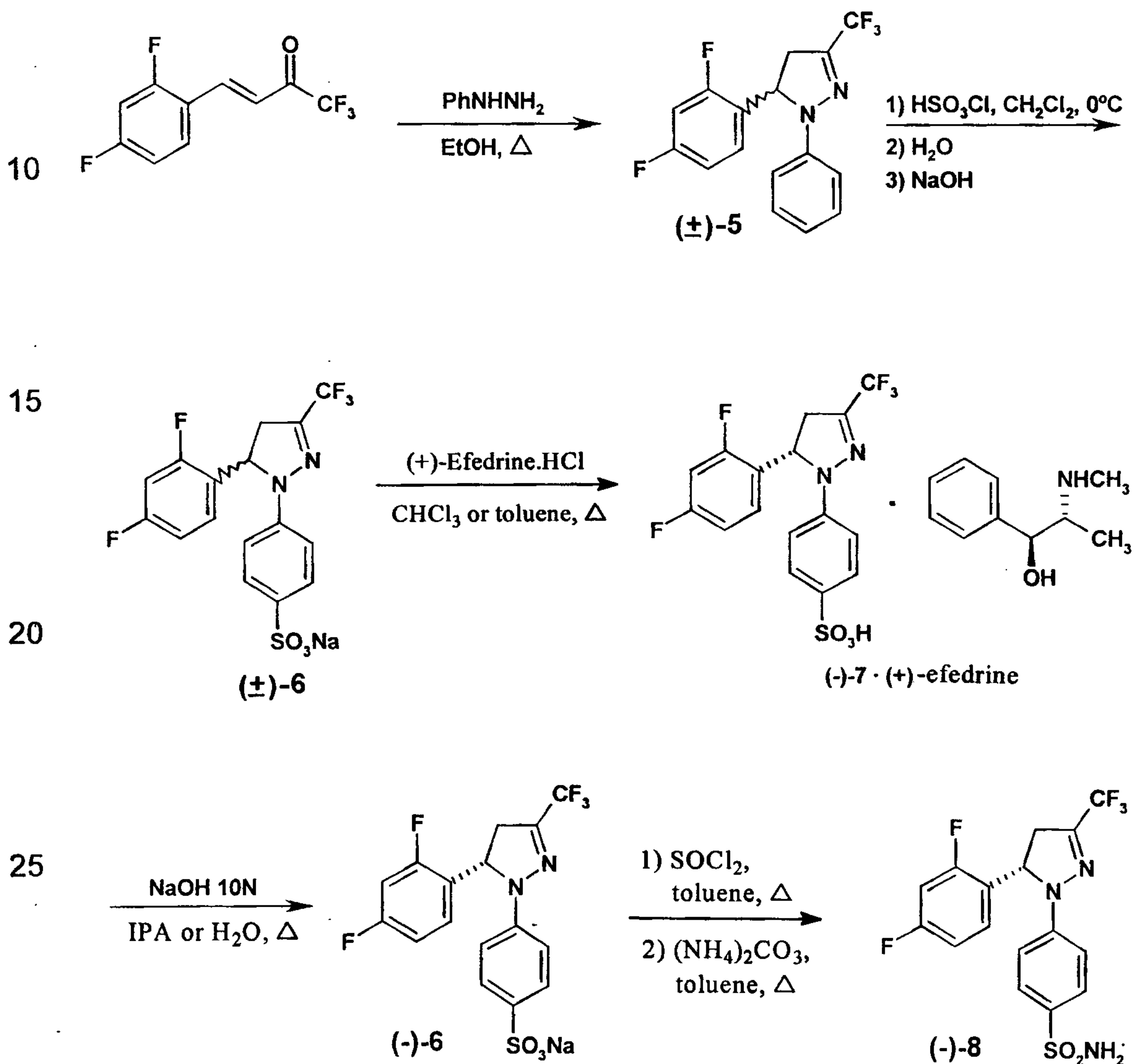
Reaction Scheme 1

27395-151

6

The process developed in the present invention is described schematically below for two specific examples: firstly (Reaction Scheme 2) for obtaining the enantiomerically pure compound (-)-8.

### 5 Reaction Scheme 2



The compound (-)-8 is synthesised, in accordance with the present invention, by the method described below with the schematic indicating certain preferred conditions. The third stage comprises the resolution of the racemic mixture (±)-6 into its two enantiomers, using as a resolution agent (+)-ephedrine. Ephedrine is an excellent resolving agent, as both enantiomers can

be used in the resolution, they are available in a high enantiomeric concentration, are commercially available and are easily recoverable and crystallisable. The compound (+)-**8** is prepared by the same synthesis path as in the previous case, changing only the ephedrine enantiomer in the resolution process (step 3). Synthesis of the racemic compound ( $\pm$ )-**8** is performed in the same manner, skipping the steps related to resolution, that is, directly by reaction of the acid chloride with ammonium or ammonium carbonate.

The first stage consists of preparing the pyrazoline ( $\pm$ )-**5** from (*E*)-1,1,1-trifluoro-4-(2,4-difluorophenyl)-3-buten-2-one and phenylhydrazine, in a suitable solvent, for example in alcohols such as methanol, ethanol or isopropanol, or in the absence of a solvent. The reaction takes place in an acid medium, which can be organic such as acetic acid or p-toluensulphonic acid, or inorganic such as hydrochloric acid, or a mixture of both, or instead in an alkali medium such as in piperidine, piperazine, sodium hydroxide, potassium hydroxide, sodium methoxide or sodium ethoxide, or a mixture thereof. The same acid or alkali medium can also act as a solvent. The most suitable temperatures range from ambient temperature to 150°C, and reaction times lie between 2 and 48 hours. Purification of pyrazoline ( $\pm$ )-**5** is carried out by crystallisation.

20

In the second step a sulphonation is performed on the pyrazoline ( $\pm$ )-**5** with chlorosulphonic acid without a solvent or using a chlorinated solvent such as dichloromethane at temperatures ranging between 0°C and the boiling temperature of the solvent, providing the corresponding sulphonic acid after an aqueous treatment. Addition of sodium hydroxide precipitates the sodium sulphonate ( $\pm$ )-**6**.

In the third step the racemic mixture ( $\pm$ )-**6** is resolved into its two enantiomers by forming a mixture of two diastereoisomeric salts and the subsequent separation of one of these by precipitation in the same reaction medium. The process object of the present invention does not suffer from the aforementioned drawbacks in resolution of a similar product as performed by Mukai *et al.* [*Can. J. Chem.* **1979** 57, 360-366], and separation of the two diastereoisomeric salts is performed in the same reaction medium during the process of forming the mixture of diastereoisomeric salts, that is, a single

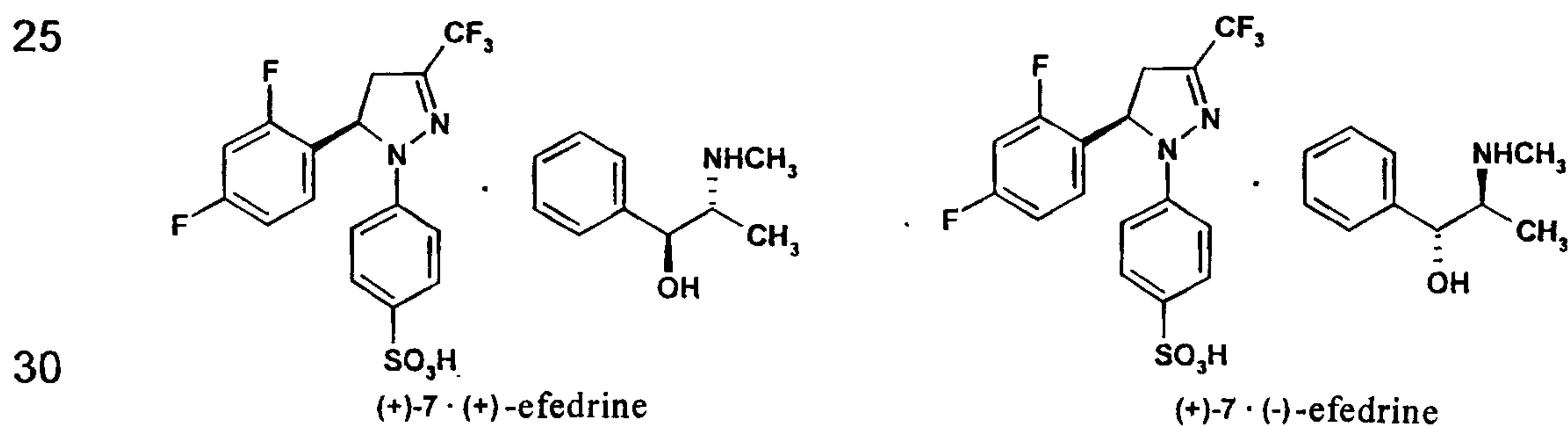
35

27395-151

8

crystallisation is required. The resolution agent employed is (+)-ephedrine, which by reaction of the racemic mixture ( $\pm$ )-6 with (+)-ephedrine chlorhydrate in a chlorinated solvent such as chloroform and at temperatures oscillating ranging from ambient temperature and the reflux temperature provides the mixture of diastereoisomeric salts, and in the cooling process only the enantiomer (-)-7 precipitates in the form of a salt of (+)-ephedrine, with an enantiomeric excess above 98%. It is possible to obtain from the filtration liquids the diastereoisomeric salt of (+)-7 and (+)-ephedrine, by evaporation of the solvent and subsequent recrystallisation in an alcohol, such as isopropyl alcohol, or mixtures of an alcohol and water. In addition, by the same process of step 3 of the schematic but using (-)-ephedrine chlorhydrate, the diastereoisomeric salt formed by (+)-7 and (-)-ephedrine is obtained by precipitation and from the filtration liquids can be obtained the diastereoisomeric salt of (-)-7 and (-)-ephedrine, by evaporation of the solvent and subsequent recrystallisation in an alcohol, such as isopropyl alcohol, or mixtures of an alcohol and water.

In the fourth stage shown in the reaction scheme the sodium sulphonate (-)-6 is released in enantiomerically pure form by basic hydrolysis of the salt (-)-7·(+)-ephedrine, with aqueous sodium hydroxide and using an alcohol such as isopropanol as solvent. From the filtration liquids it is simple to recover the ephedrine by eliminating the solvent and acidifying the residue dissolved in ethanol with ethanolic hydrochloric acid. The enantiomer (+)-6 is obtained in the same manners from the salt (+)-7·(+)-ephedrine or (+)-7·(-)-ephedrine.



The fifth and last step shown in the schematic comprises the preparation of the stereoisomer (-)-8 with an enantiomeric excess above 98% by reaction of the optically active sodium sulphonate (-)-6 with thionyl chloride in the absence of a

27395-151

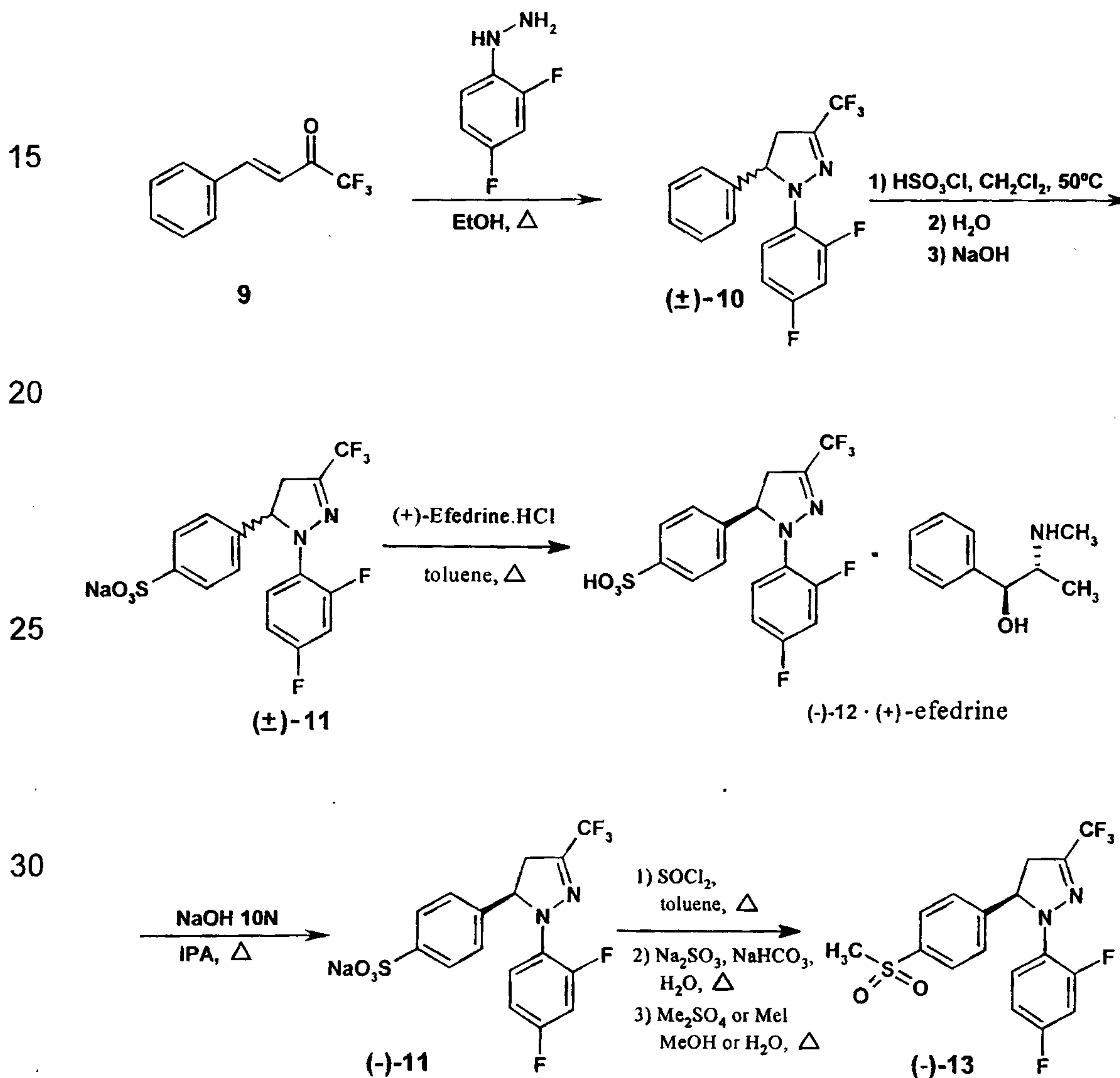
9

solvent or in a suitable solvent such as toluene, at temperatures between ambient temperature and the reflux temperature, and subsequent formation of the sulphonamide adding ammonia or ammonium carbonate to the reaction medium. In the same manner the enantiomer (+)-8 can be obtained from (+)-6.

5 Eliminating the steps related to resolution it is possible to obtain the racemic compound ( $\pm$ )-8.

Reaction Scheme 3 shows another specific example for obtaining the compounds object of the invention: preparation of (-)-13.

### Reaction Scheme 3



The compound (-)-**13** is synthesised, according to the present invention, by the method described below, with preferred conditions indicated in the schematic. The third stage comprises the resolution of the racemic mixture ( $\pm$ )-**11** into its two enantiomers, by formation of a mixture of diastereoisomeric salts, using as a resolving agent (+)-ephedrine to obtain the enantiomer (-)-**13**. The compound (+)-**13** is prepared by the same synthesis path of the previous case, changing only the enantiomer of ephedrine in the resolution process (step 3). Synthesis of the racemic compound ( $\pm$ )-**13** is effected in the same way, skipping the formation process for the ephedrine salt and its subsequent hydrolysis.

10

The first step consists of preparation of pyrazoline ( $\pm$ )-**10** from (*E*)-1,1,1-trifluoro-5-phenyl-3-buten-2-one and 2,4-difluorophenylhydrazine chlorhydrate in a suitable solvent, such as alcohols as ethanol, or in the absence of a solvent. The reaction takes place in an acid medium, such as with acetic acid or p-toluensulphonic acid. The most suitable temperatures lie between ambient temperature and 110°C, and reaction times are between 2 and 24 hours. Purification of the pyrazoline ( $\pm$ )-**10** is performed by crystallisation.

In the second step a sulphonation is performed of the pyrazoline ( $\pm$ )-**10** with chlorosulphonic acid without a solvent or with a chlorinated solvent such as dichloromethane, at temperatures between 0°C and the boiling point of the solvent, obtaining the corresponding sulphonic acid after an aqueous treatment. Addition of sodium hydroxide precipitates the sodium sulphonate ( $\pm$ )-**11**.

In the third step the racemic mixture ( $\pm$ )-**11** is resolved into its two enantiomers by forming a mixture of two diastereoisomeric salts and a subsequent separation of one by precipitation in the same reaction medium, with a single crystallisation being required. The mixture of diastereoisomeric salts is prepared by reacting the racemic mixture ( $\pm$ )-**11** with (+)-ephedrine chlorhydrate in a suitable solvent such as toluene, at temperatures between ambient temperature and the reflux temperature. In the cooling process only the enantiomer (-)-**12** precipitates in the form of a salt of (+)-ephedrine, with an enantiomeric excess of 84%. From the filtration liquids can be obtained the diastereoisomeric salt of (+)-**12** and (+)-ephedrine. In addition, by means of the same process of step 3 of the schematic but using (-)-ephedrine chlorhydrate is

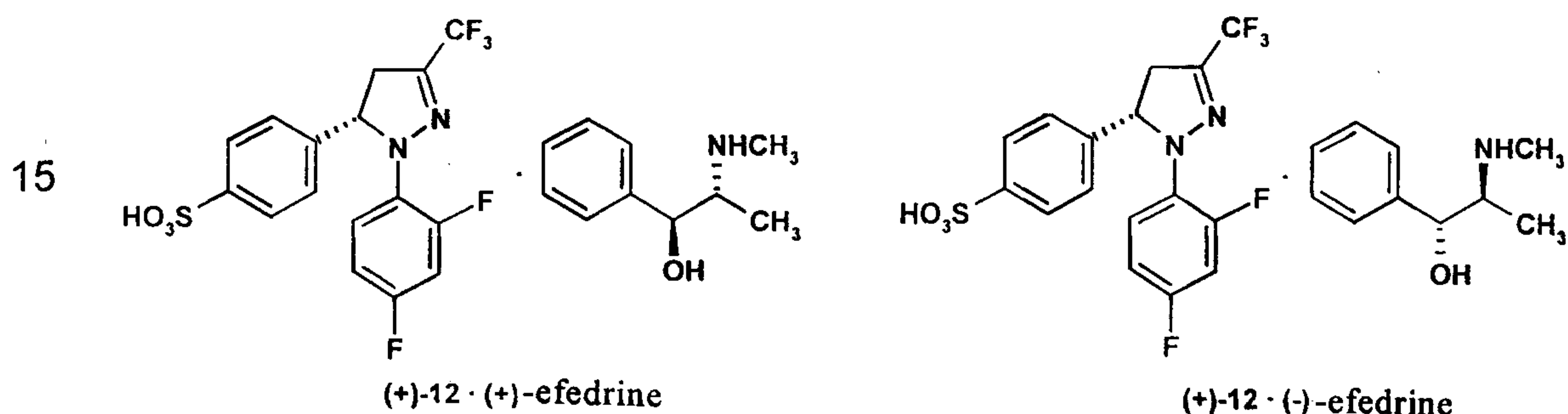
35

27395-151

11

obtained by precipitation the diastereoisomeric salt formed by (+)-12 and (-)-ephedrine and from the filtration liquids is obtained the diastereoisomeric salt of (-)-12 and (-)-ephedrine.

5 In the fourth step shown in the reaction schematic the sodium sulphonate (-)-11 is obtained enantiomerically pure by a basic hydrolysis of the salt (-)-12·(+)-ephedrine with aqueous sodium hydroxide using water as a solvent. From the filtration liquids it is simple to recover the ephedrine, as described above, by acidifying the residue dissolved in ethanol with ethanolic hydrochloric acid. Preparation of the enantiomer (+)-11 is effected in the same manner from the salt (+)-12·(+)-ephedrine or (+)-12·(-)-ephedrine.



20 In the fifth and last step shown the stereoisomer (-)-13 is prepared by reacting the optically active sodium sulphonate (-)-11 with thionyl chloride in the absence of a solvent or in a suitable solvent such as toluene, at temperatures between ambient temperature and the reflux temperature, with subsequent formation of the sodium sulphinate by reaction of the acid chloride with sodium sulphite in a basic aqueous medium, and finally by reaction of the sodium sulphinate obtained with methyl iodide or methyl sulphate in an alcoholic or aqueous medium. In the same manner the enantiomer (+)-13 is obtained from (+)-11. Eliminating the steps related to the resolution the racemic compound (±)-13 is obtained.

25

30

The resolution process object of the present invention can be used or racemic mixtures (those in which the two enantiomers are present in the ratio 1:1) or for non racemic mixtures in which one of the enantiomers is predominant, obtained by any physical or chemical method.

35

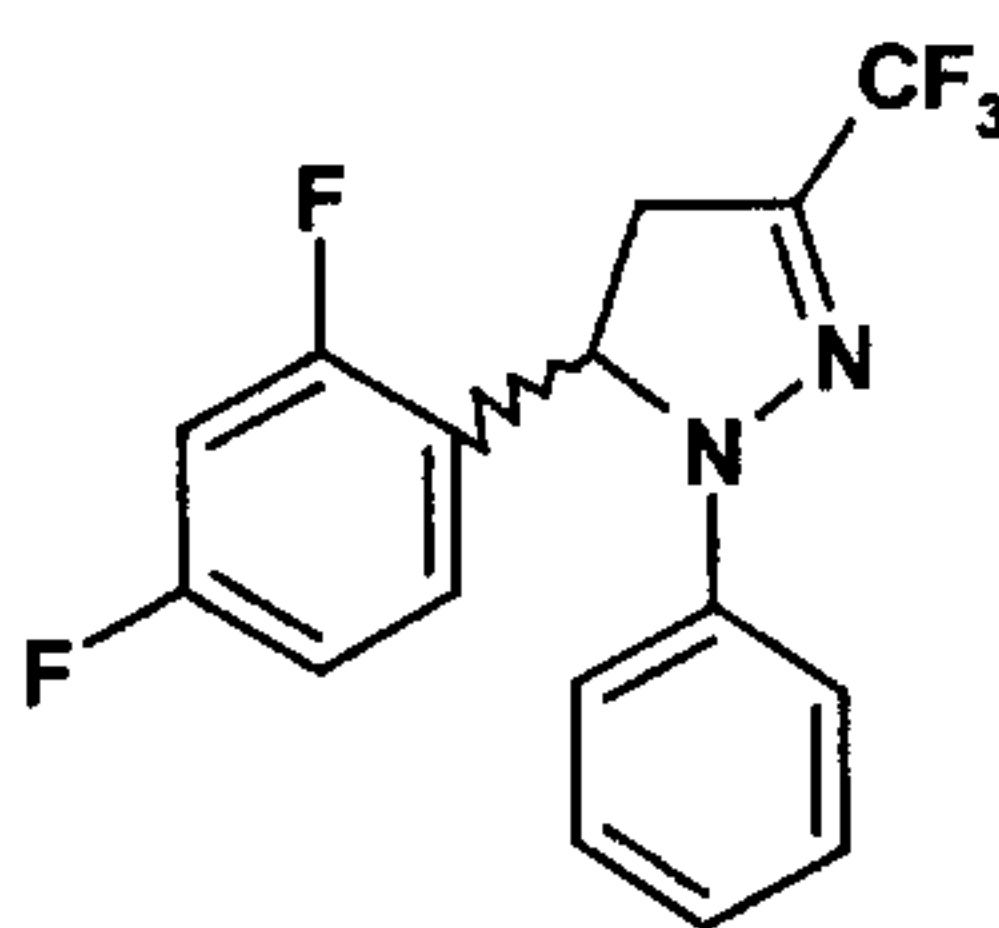
Below is shown by way of example the process for preparation of some of the compounds to which the present invention relates. These examples are shown for purposes of illustration only and should not be considered to limit the scope of the invention in any way.

5

Example 1: Preparation of (-)-4-[5-(2,4-difluorophenyl)-4,5-dihydro-3-(trifluoromethyl)-1H-pyrazol-1-yl]-benzenesulphonamide, (-)-8

Preparation of (±)-1-phenyl-5-(2,4-difluorophenyl)-4,5-dihydro-3-trifluoromethyl-1H-pyrazol, (±)-5

15



20

In a 50 mL beaker are introduced (E)-1,1,1-trifluoro-4-(2,4-difluorophenyl)-3-buten-2-one (2.66 g, 11.2 mmol), monohydrated *p*-toluensulphonic acid (2.1 g, 11.2 mmol) and phenylhydrazine chlorhydrate (1.33 g, 12.3 mmol) and heated to 110°C. A small amount of ethyl alcohol can be used to facilitate the initial mixture. After approximately 2 h (control by CCF) the mixture is allowed to cool and it is diluted with ethyl acetate. It is then washed with a saturated solution of NaHCO<sub>3</sub>, dried with MgSO<sub>4</sub>, filtered and the solvent evaporated at low pressure. The crude thus obtained (3.9 g) is recrystallised with methanol (2 mL) to precipitate 3.67 g (65%) of the pyrazoline (±)-5: pf = 83-84°C; IR (KBr)  $\mu$  max (cm<sup>-1</sup>) 1600, 1505, 1326; <sup>1</sup>H-RMN (CDCl<sub>3</sub>)  $\delta$  (ppm): 7.28-6.72 (m, 8H), 5.64 (dd, J= 13Hz, J= 7.5Hz, 1H), 3.8-3.6 (m, 1H), 2.94 (dd, J= 17.2Hz, J= 7Hz, 1H).

30

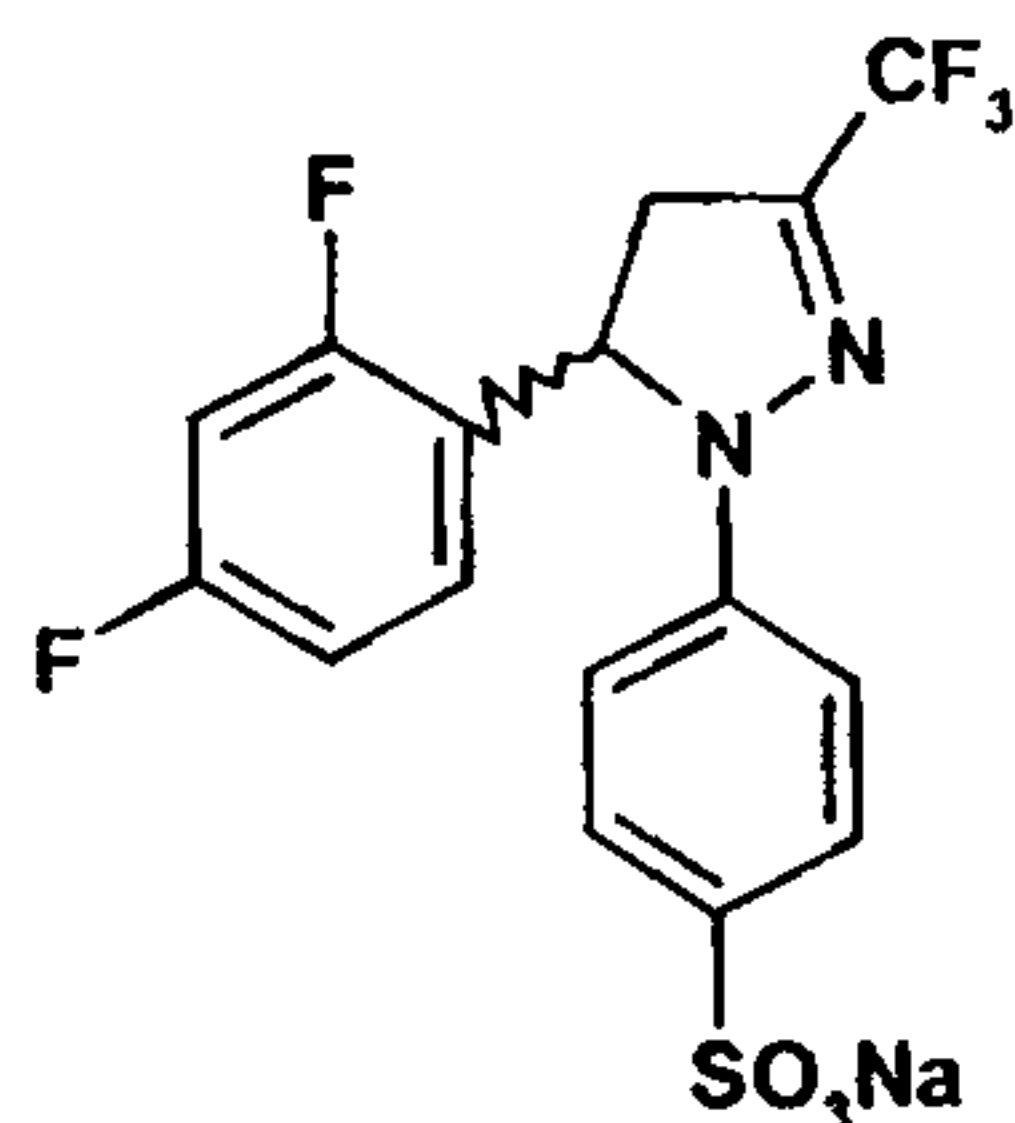
Preparation of (±)-4-[5-(2,4-difluorophenyl)-4,5-dihydro-3-(trifluoromethyl)-1H-pyrazol-1-yl]-sodium benzenesulphonate, (±)-6

35

27395-151

13

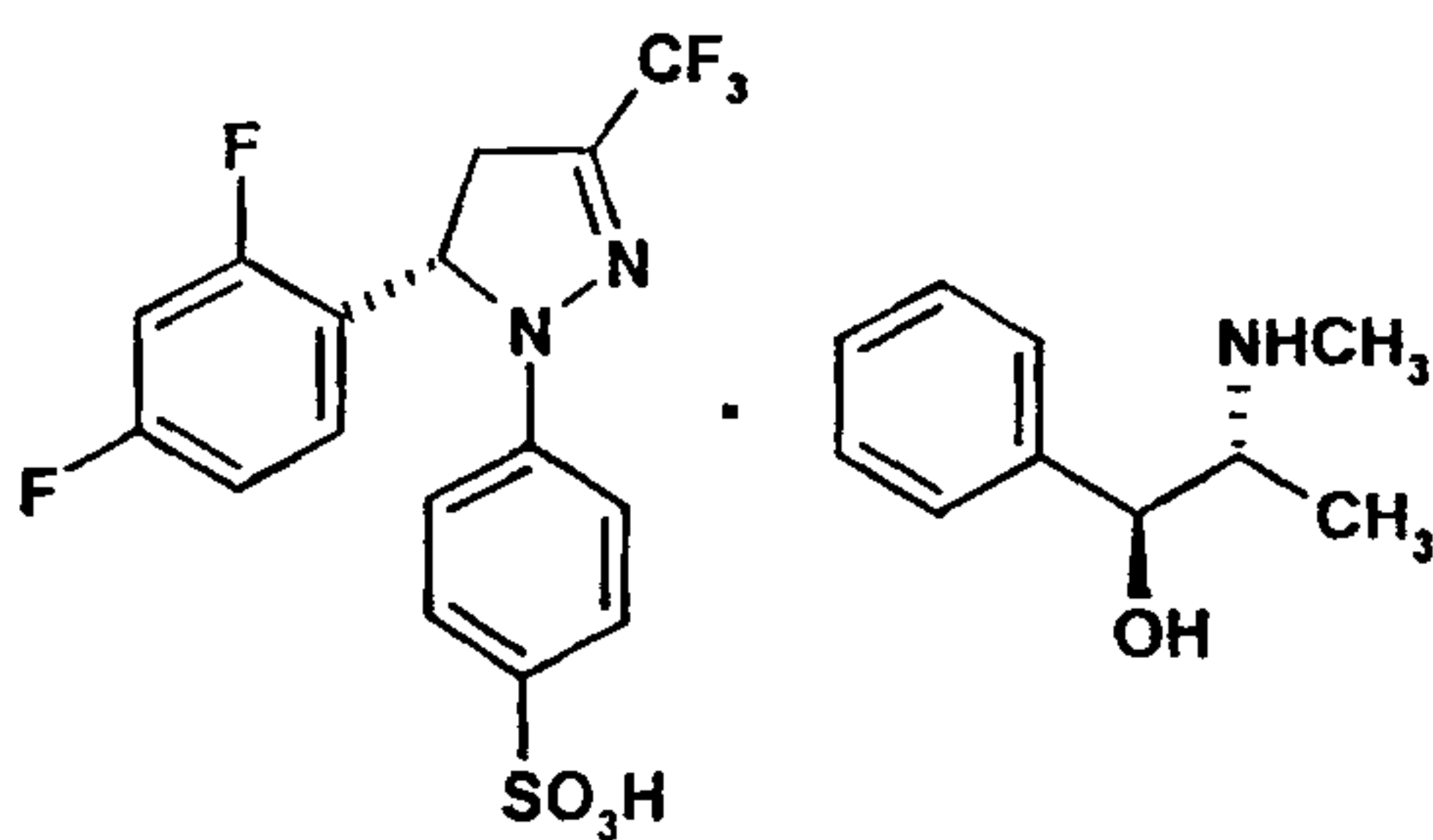
5



In a 100 mL beaker the pyrazoline (±)-5 (4.0 g, 12.27 mmol) is dissolved in dichloromethane (12 mL). The mixture is cooled at 0°C and added on it drop by drop is chlorosulphonic acid (0.82 mL, 12.27 mmol). The stirring and temperature are maintained for 20 minutes, after which time the reaction mixture is slowly added on water (20 mL) at 4°C, stirring the assembly for 14 h at ambient temperature. The two phases are separated and the aqueous phase is washed with dichloromethane (5 mL). The aqueous phase is concentrated to two thirds of the initial volume and to this is added, under stirring, an aqueous solution of sodium hydroxide 1M (12.27 mL, 12.27 mmol). This precipitates a white solid which corresponds to sodium sulphonate (±)-6, which is filtered, washed with more water and dried (3.93 g, 75% yield): pf = 292-295°C; IR (KBr)  $\mu$  max (cm<sup>-1</sup>) 3430, 1600, 1570, 1425; <sup>1</sup>H-RMN (CDCl<sub>3</sub>/CD<sub>3</sub>OD: 10/1)  $\delta$  (ppm): 7.6 (d, J=8.8 Hz, 2H), 7.1-6.7 (m, 3H), 6.9 (d, J=8.8 Hz, 2H), 5.69 (dd, J=12.6 Hz, J= 6.3 Hz, 1H).

Preparation of (-)-4-[5-(2,4-difluorophenyl)-4,5-dihydro-3-(trifluoromethyl)-1H-pyrazol-1-yl]-benzenesulphonate of (+)-ephedrine, (-)-7·(+)-ephedrine.

25



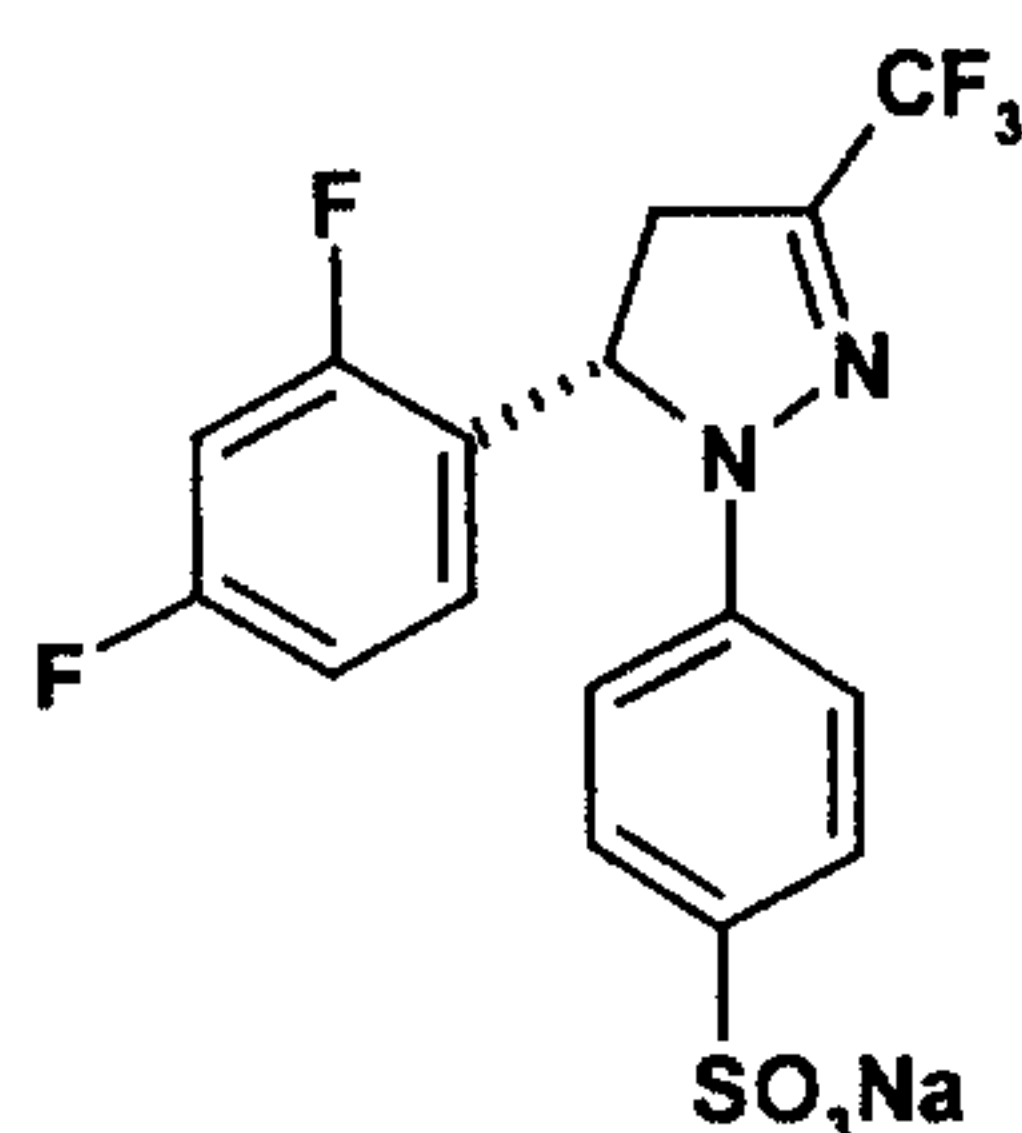
30

In a 2L beaker are introduced sodium sulphonate (±)-6 (3.95 g, 9.23 mmol), (+)-ephedrine chlorhydrate (1.86 g, 9.23 mmol) and chloroform (79 mL). The mixture is shaken and heated to reflux for 10 minutes. It is allowed to cool

35

slowly to ambient temperature, precipitating a solid (2.49 g) mixture of the salt (-)-7·(+)-ephedrine (enantiomeric excess above 98%) and sodium chloride formed in the process. This sample is used directly in the following reaction. If the sample is dissolved with a small amount of AcOEt, Washed with water, dried with MgSO<sub>4</sub> and the solvent is evaporated a pure fraction is obtained of the salt (-)-7·(+)-ephedrine:  $[\alpha]_{20}^D = -94.6$  (c=2, MeOH); IR (KBr)  $\mu$  max (cm<sup>-1</sup>): 3410, 3040, 2860, 2780, 1595, 1570, 1500, 1420; <sup>1</sup>H-RMN (CDCl<sub>3</sub>/CD<sub>3</sub>OD: 10/1)  $\delta$  (ppm): 7.7 (d, J= 9Hz, 2H), 7.4-7.2 (m, 5H), 7.1-6.7 (m, 3H), 6.95 (d, J= 9Hz, 2H), 5.65 (dd, J= 12.5Hz, J= 6.5Hz, 1H), 5.3 (d, J= 2.2Hz, 1H), 3.9-3.6 (m, 1H), 3.4-3.1 (m, 1H), 3.0 (dd, J= 18.4Hz, J= 5.8Hz, 1H), 2.76 (s, 3H), 1.9 (wide band, 1H), 1.0 (d, J= 6Hz, 3H).

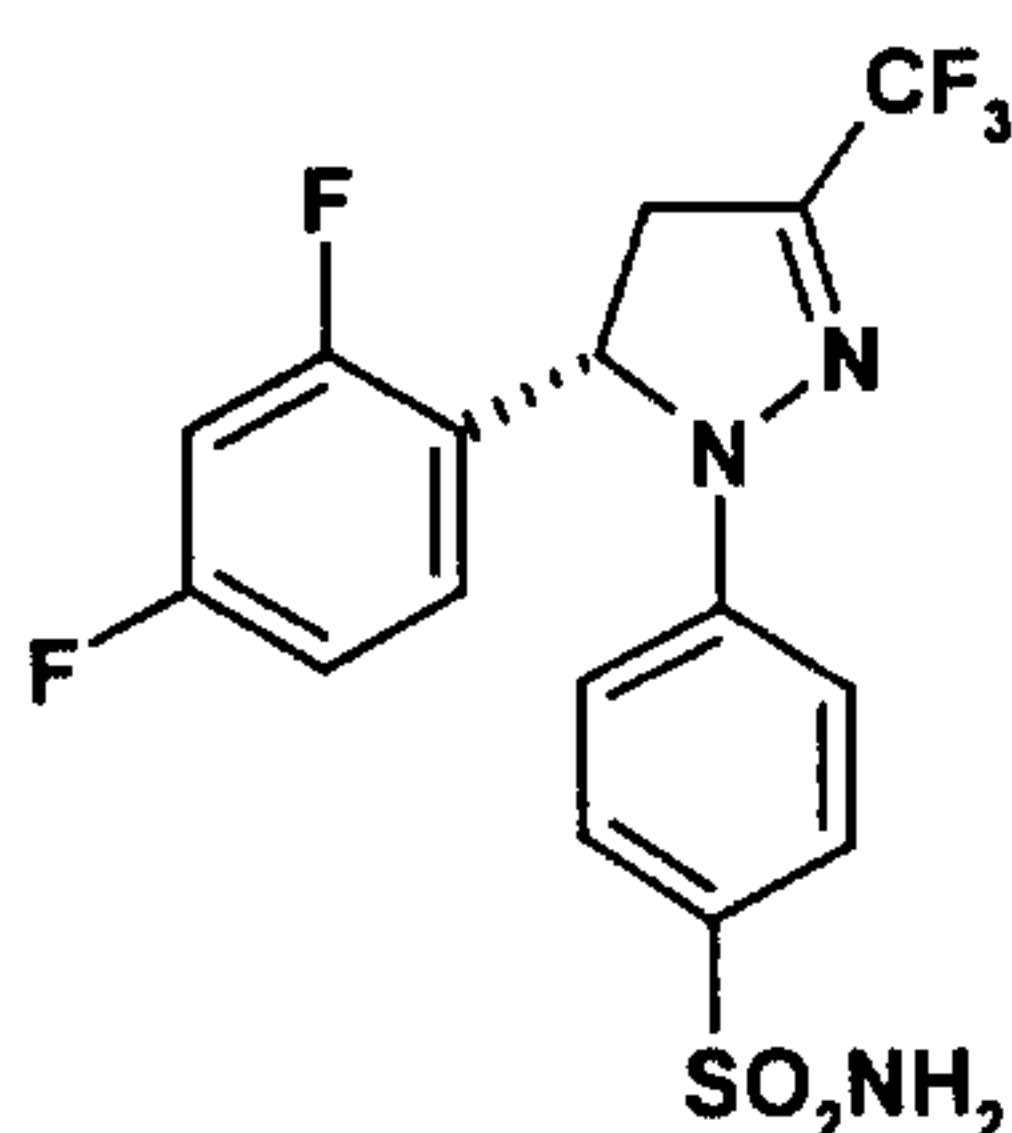
Preparation of (-)-4-[5-(2,4-difluorophenyl)-4,5-dihydro-3-(trifluoromethyl)-1H-pyrazol-1-yl]-sodium benzenesulphonate, (-)-6



In a 50 mL beaker are introduced isopropyl alcohol (50 mL) and a mixture of the salt (-)-7·(+)-ephedrine (enantiomeric excess above 98%) and sodium chloride (2.49 g). The suspension obtained is shaken and sodium hydroxide 10M (0.4 mL) is added on it. The solution is heated to reflux and 10 minutes later it is allowed to cool slowly to ambient temperature. A precipitate is obtained which once filtered, washed with isopropyl alcohol and dried corresponds to a mixture of sodium sulphonate (-)-6 and sodium chloride (1.86 g), which is directly used in the preparation of (-)-8. In order to determine the optical rotation of the compound (-)-6 it is possible to purify part of the sample by washing with water:  $[\alpha]_{20}^D = -170.1$  (c=1, MeOH).

Preparation of (-)-4-[5-(2,4-difluorophenyl)-4,5-dihydro-3-(trifluoromethyl)-1H-pyrazol-1-yl]-benzenesulphonamide, (-)-8.

5



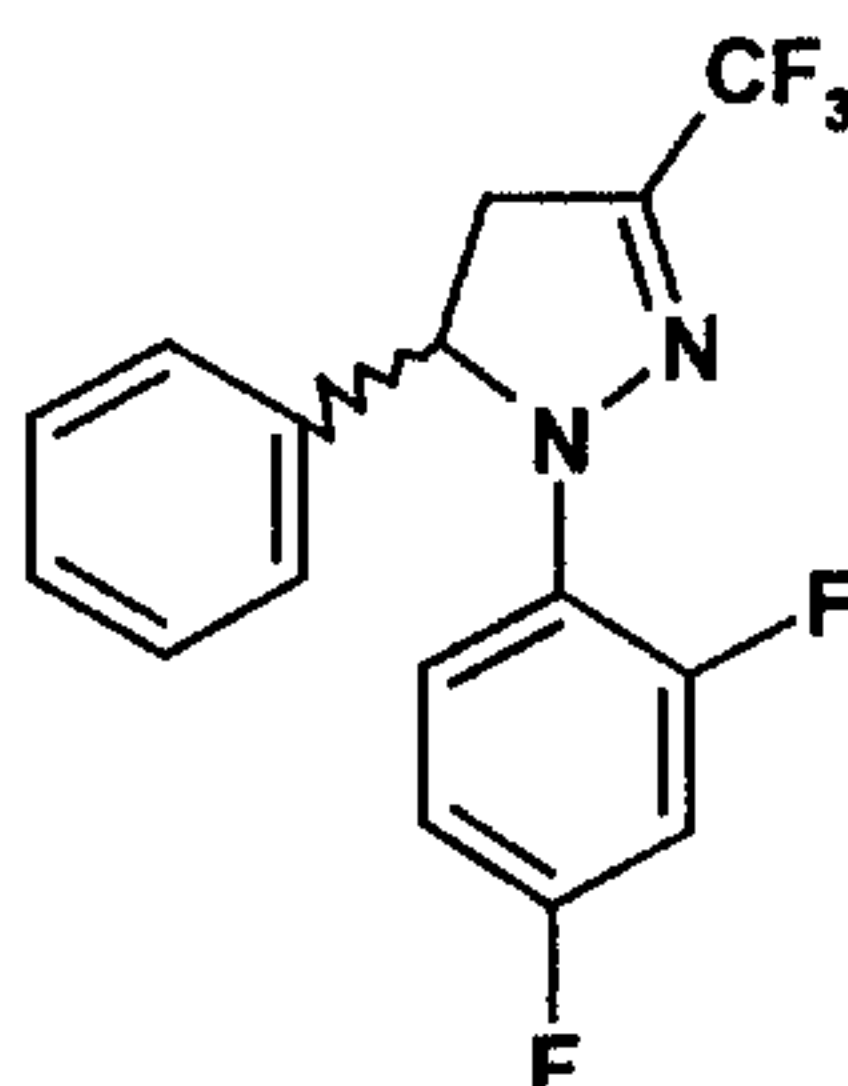
In a 1 L beaker is introduced a sample (72 g) mixture of sodium  
 10 sulphonate (-)-6 (48.3 g, 112.8 mmol) and NaCl (23.7 g) on toluene (250 mL).  
 The suspension is heated to 60°C, thionyl chloride is added (18 mL, 247.5  
 mmol), it is heated to reflux and left at this temperature for 2 hours at least. After  
 the acid chloride formation reaction has finished the excess thionyl chloride is  
 15 eliminated by its azeotropic distillation with toluene (190 mL; 76°C at 60 mmHg).  
 More toluene is added (190 mL) and it is again distilled in the same conditions.

For preparation of the sulphonamide the previous sample is diluted with  
 toluene (190 mL), the mixture is cooled to 70°C, solid ammonium carbonate is  
 added (22.6 g, 235 mmol), it is heated to 90°C and shaken at this temperature  
 20 for 2 h. When the reaction has finished (if necessary more ammonium  
 carbonate is provided) water is added (300 mL) and it is maintained for 30  
 minutes at 90°C. the mixture is cooled to ambient temperature and an aqueous  
 solution of 17.5% HCl is added until obtaining a pH of 6 - 7 and it is kept stirred  
 for another 10 minutes. The precipitated solid is filtered, washed with toluene  
 25 and dried to provide the sulphonamide (-)-8 (38.4 g, 84% yield). The product  
 can be recrystallised with a mixture of isopropyl alcohol and water (60:40),  
 giving an ee above 99%: pf= 173-174°C;  $[\alpha]_{20}^D = -192.8$  (c=1, MeOH); IR (KBr)  
 $\mu$  max (cm<sup>-1</sup>): 3310, 3230, 1600, 1500, 1430; <sup>1</sup>H-RMN (CDCl<sub>3</sub>)  $\delta$  (ppm): 7.76  
 (d, J= 9Hz, 2H), 7.04 (d, J= 9Hz, 2H), 7.1-6.75 (m, 3H), 5.71 (dd, J= 12.4 Hz, J=  
 30 6.2 Hz, 1H), 4.74 (s, 2H), 3.9-3.7 (m, 1H), 3.03 (dd, J= 19.8Hz, J= 6.2Hz, 1H).

Example 2: Preparation of (-)-1-(2,4-difluorophenyl)-4,5-dihydro-5-(4-methylsulphonylphenyl)-3-(trifluoromethyl)-1H-pyrazol, (-)-13

35 Preparation of (±)-1-(2,4-difluorophenyl)-4,5-dihydro-5-phenyl-3-

(trifluoromethyl)-1*H*-pyrazol, (±)-**10**

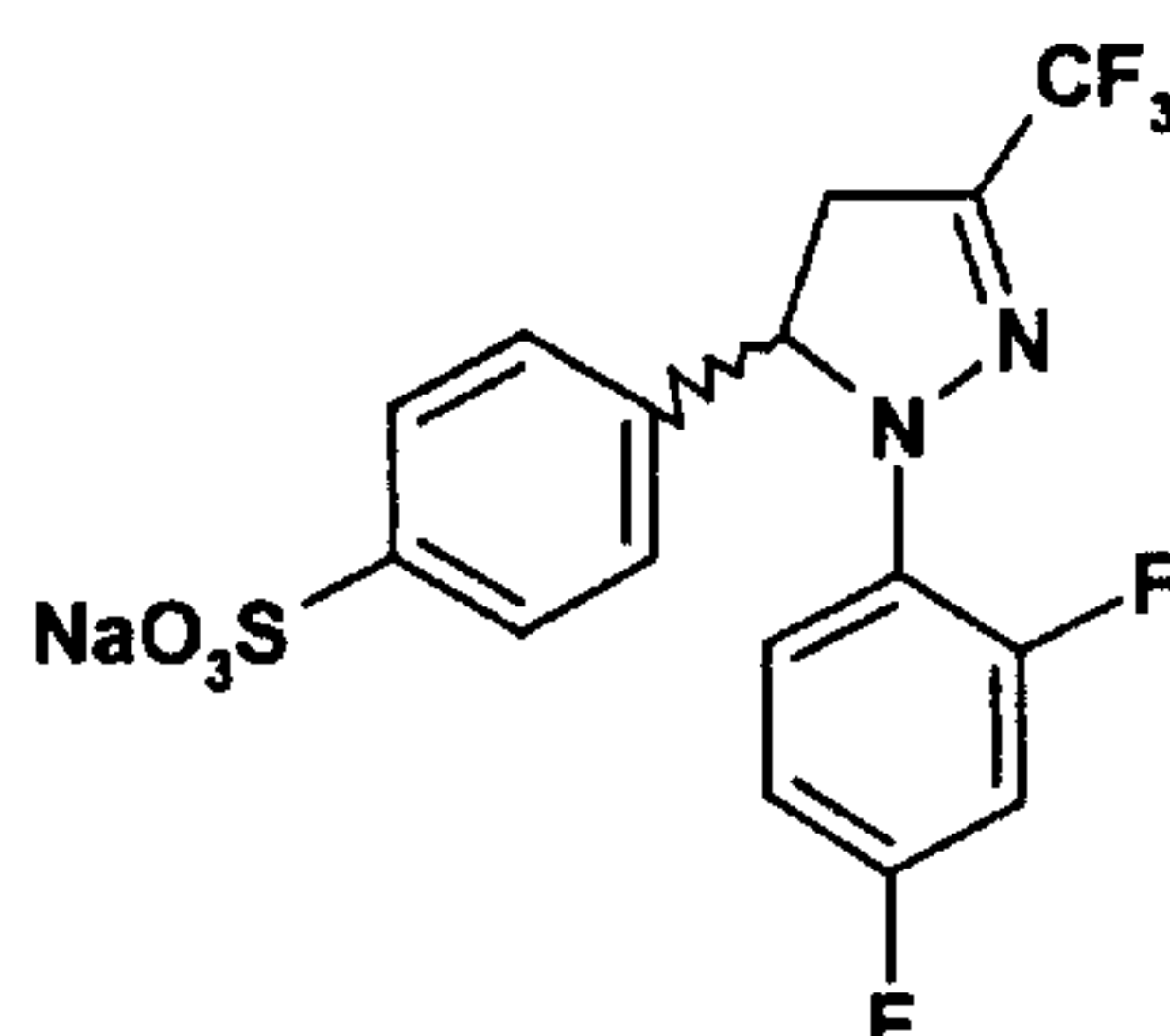


5

In a 50 mL beaker are introduced (*E*)-1,1,1-trifluoro-5-phenyl-3-buten-2-one (3.04 g, 15.2 mmol), monohydrated *p*-toluensulphonic acid (2.9 g, 15.2 mmol) and 2,4-difluorophenylhydrazine chlorhydrate (3.01 g, 16.7 mmol) and heated to 110°C. A small amount of ethyl alcohol can be used to facilitate the initial mixture. After approximately 2 hour (controlled by CCF) the mixture is allowed to cool and it is diluted with ethyl acetate. It is washed with a saturated solution of NaHCO<sub>3</sub>, dried with MgSO<sub>4</sub>, filtered and the solvent is evaporated at low pressure. The crude thus obtained is recrystallised with isopropyl alcohol (1g / 1 mL) precipitating 3.95 g (80%) of pyrazoline (±)-**10**: pf = 52-54°C; IR (KBr)  $\mu$  max (cm<sup>-1</sup>) 1598, 1511, 1414, 1324; <sup>1</sup>H-RMN (CDCl<sub>3</sub>)  $\delta$  (ppm): 7.4-6.6 (m, 8H), 5.7-5.4 (m, 1H), 3.8-3.5 (m, 1H), 3.3-3.0 (m, 1H).

20

Preparation of (±)-4-[1-(2,4-difluorophenyl)-4,5-dihydro-3-(trifluoromethyl)-1*H*-pyrazol-5-yl]-sodium benzenesulphonate, (±)-**11**



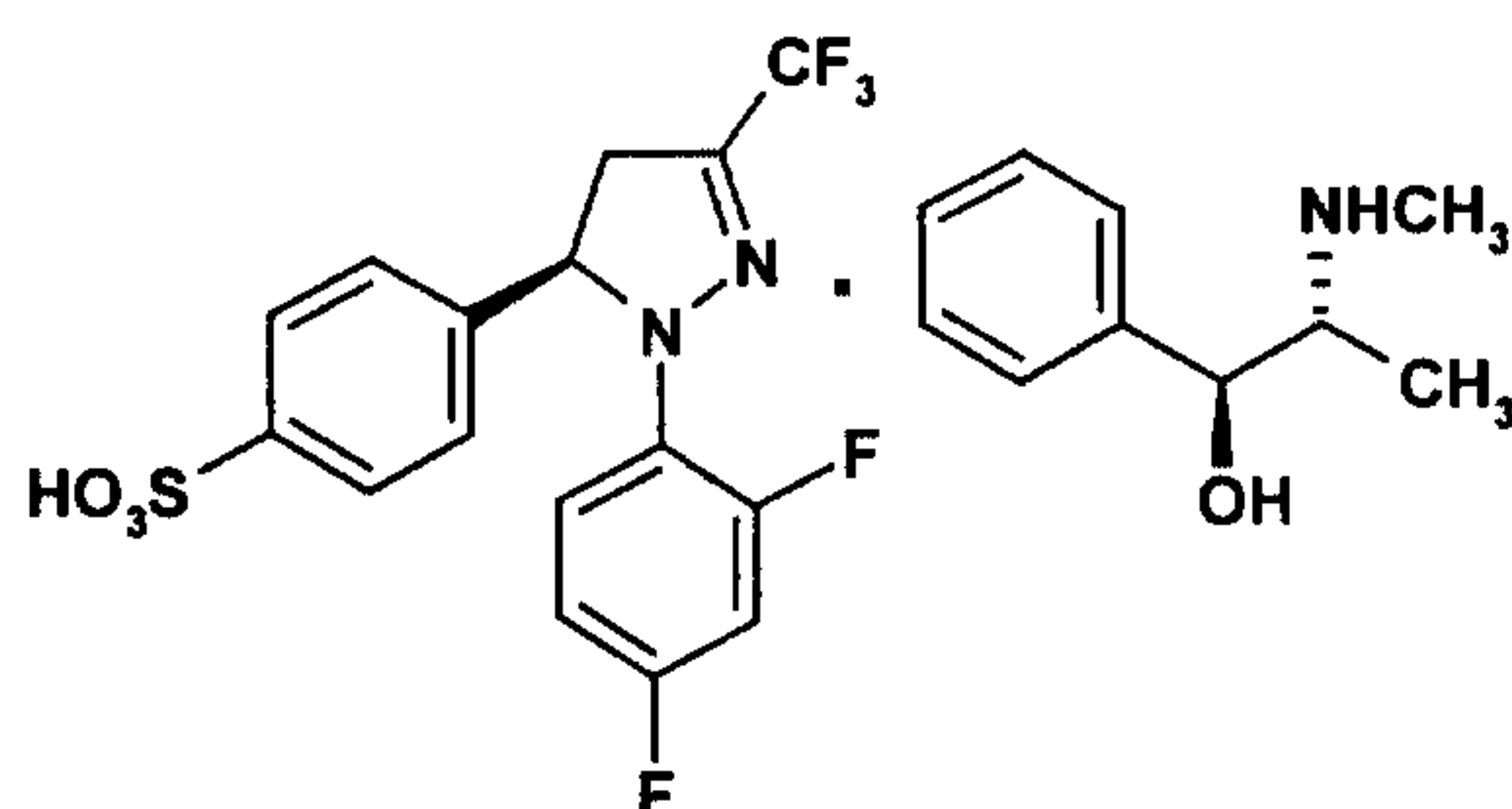
25

In a 100 mL beaker are dissolved pyrazoline (±)-**10** (3.0 g, 9.2 mmol) in dichloromethane (1.5 mL). The mixture is cooled to 0°C and onto it is added, drop by drop, chlorosulphonic acid (6.1 mL, 92 mmol). Coolant is coupled to it and the temperature is increased to 50°C. The shaking and temperature are maintained during 5 hours (controlled by CCF), the mixture is allowed to cool and diluted with dichloromethane (90 mL), at which time the reaction is slowly

35

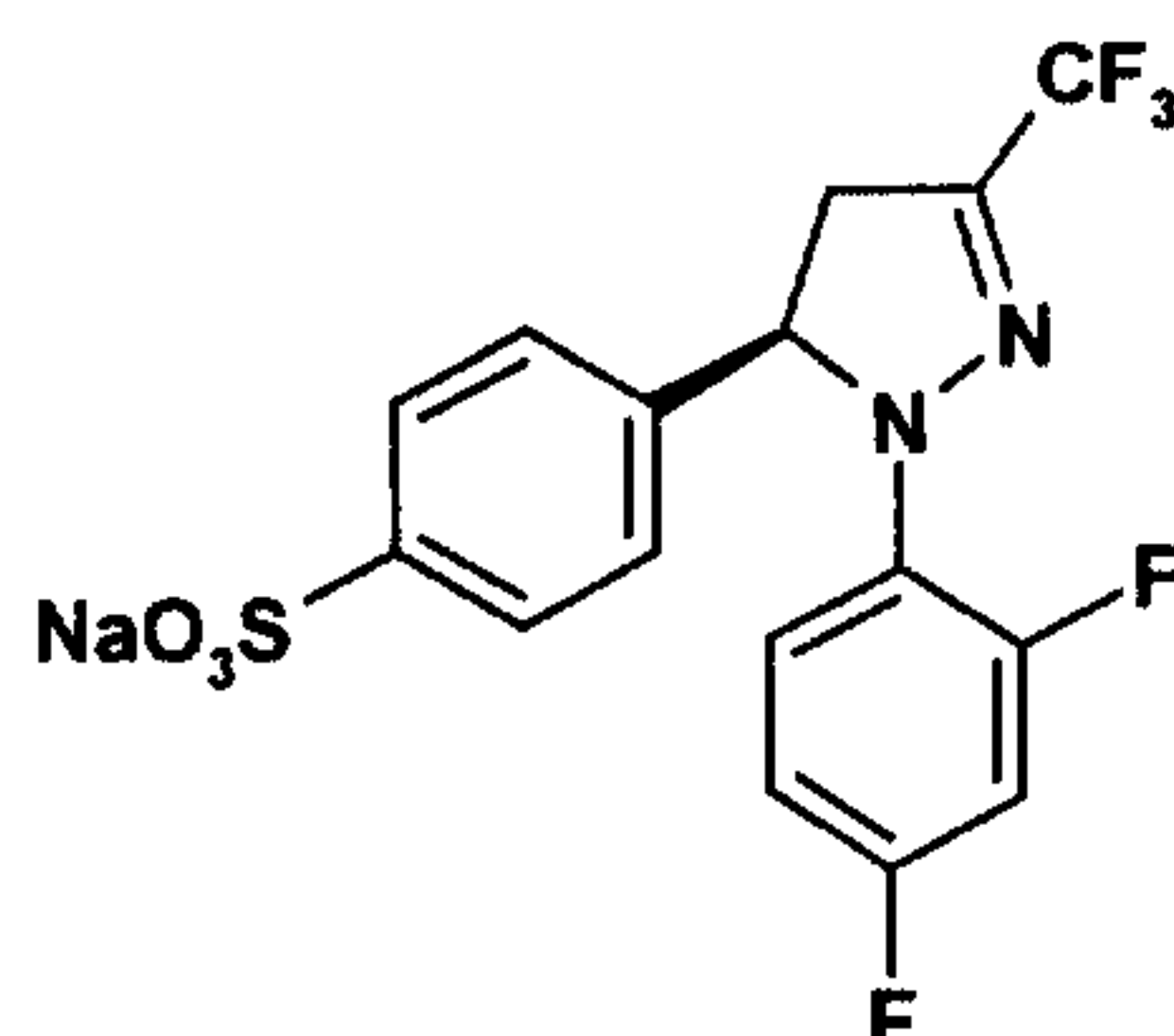
added on water (90 mL) at 4°C. the two phases are separated and two extractions are performed of the aqueous phase with dichloromethane (25 mL). The organic phase is dried with MgSO<sub>4</sub>, filtered and the solvent evaporated at low pressure. The crude thus obtained (3.6 g) is introduced in a 25 mL beaker coupled to a coolant and on it is added water (13.4 mL). The suspension is heated to 70°C and slowly added onto it, stirring, is an aqueous solution of sodium hydroxide 10M (1.7 mL, 17.04 mmol). The mixture is heated to reflux and is kept at this temperature for 10 minutes. It is allowed to cool slowly until reaching ambient temperature, precipitating a white solid that corresponds to sodium sulphonate (±)-**11**, which is filtered, washed with more water and dried (3.0 g, 82% yield): pf = 271-273°C; IR (KBr)  $\mu$  max (cm<sup>-1</sup>) 3477, 1617, 1513, 1416; <sup>1</sup>H-RMN (CDCl<sub>3</sub>)  $\delta$  (ppm): 7.59 (d, J=8.5 Hz, 2H), 7.3-7.0 (m, 3H), 6.95 (d, J=8.5 Hz, 2H), 5.4 (m, 1H), 3.5 (m, 1H), 2.9 (m, 1H).

Preparation of (-)-4-[1-(2,4-difluorophenyl)-4,5-dihydro-3-(trifluoromethyl)-1H-pyrazol-5-yl]-benzenesulphonate of (+)-ephedrine, (-)-**12**·(+)-ephedrine.



In a 50 mL beaker are introduced sodium sulphonate (±)-**11** (2.45 g, 5.72 mmol), (+)-ephedrine chlorhydrate (1.15 g, 5.72 mmol) and toluene (24.5 mL). The mixture is shaken and heated to reflux for 10 minutes. It is allowed to cool slowly until reaching ambient temperature, precipitating a solid which is filtered and washed with more toluene. This provides 1.18 g, mixture of the salt (-)-**12**·(+)-ephedrine (enantiomeric excess of 84%) and of the sodium chloride formed in the process. This sample is directly used in the following reaction; IR (KBr)  $\mu$  max (cm<sup>-1</sup>) 3377, 3031, 1603, 1515, 1399; <sup>1</sup>H-RMN (CDCl<sub>3</sub>/CD<sub>3</sub>OD: 10/1)  $\delta$  (ppm): 7.76 (d, J= 8Hz, 2H), 7.4-7.2 (m, 6H), 7.19 (d, J=8Hz, 2H), 6.75 (m, 2H), 5.6 (m, 1H), 5.35 (s, 1H), 3.65 (m, 1H), 3.3 (m, 1H), 3.15-3.0 (m, 1H), 2.76 (s, 3H), 2.65 (m, 2H), 1.07 (d, J= 7Hz, 3H).

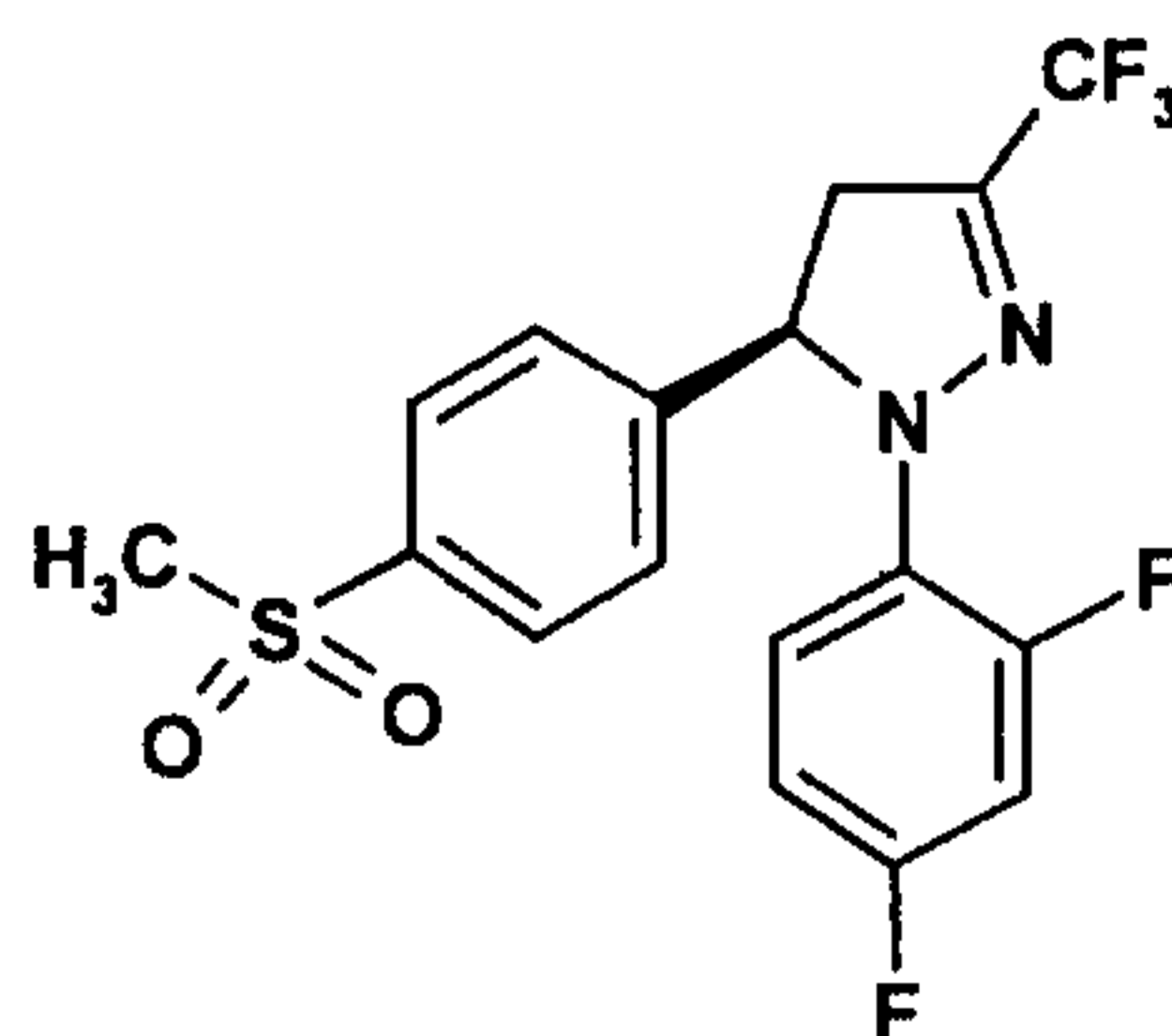
Preparation of (-)-4-[1-(2,4-difluorophenyl)-4,5-dihydro-3-(trifluoromethyl)-1H-pyrazol-5-yl]-sodium benzenesulphonate, (-)-11



10

In a 10 mL beaker are introduced water (2.8 mL) and the mixture (1 g) of the salt (-)-7-(+)-ephedrine and sodium chloride (28% of total weight). The suspension obtained is shaken and added to it is sodium hydroxide 10M (0.3 mL). The solution is heated to reflux and 10 minutes later allowed to cool slowly to ambient temperature. A precipitate is obtained which once filtered, washed with water and dried corresponds to sodium sulphonate (-)-11 (0.34 g), which is used directly in preparation of the compound (-)-13:  $[\alpha]_{20}^D = -104.3$  (c=1, MeOH).

Preparation of (-)-1-(2,4-difluorophenyl)-4,5-dihydro-5-(4-methylsulphonylphenyl)-3-(trifluoromethyl)-1H-pyrazol, (-)-13.



25

In a 10 mL beaker are dissolved the compound (-)-11 (230 mg, 0.54 mmol) in toluene (1.1 mL). The suspension is heated to 60°C, thionyl chloride is added (88  $\mu$ L, 1.18 mmol), and it is kept at said temperature for at least 2 hours. At the end of the acid chloride formation reaction the excess thionyl chloride is eliminated by azeotropic distillation with toluene (76°C at 60 mmHg). More toluene (1 mL) is added and again distilled in the same conditions. On the crude

35

thus obtained are added water (1.15 mL), NaHCO<sub>3</sub> (95 mg, 1.13 mmol) and Na<sub>2</sub>SO<sub>3</sub> (124 mg, 0.97 mmol), heating to 75°C. It is kept at this temperature for 2 hours and then allowed to cool to room temperature. The solvent is evaporated at low pressure and on the crude is added methyl alcohol (14 mL).

5 After 1 hour at reflux it is filtered hot and the solvent evaporated at reduced pressure. The solid thus obtained (297 mg) is dissolved in methyl alcohol (2.8 mL) and onto this is added methyl iodide (44 µL, 0.7 mmol). This is heated to 55°C and kept at this temperature for 16 hours. The solvent is evaporated at low pressure, yielding 168 mg (77%) of crude. The product can be recrystallised

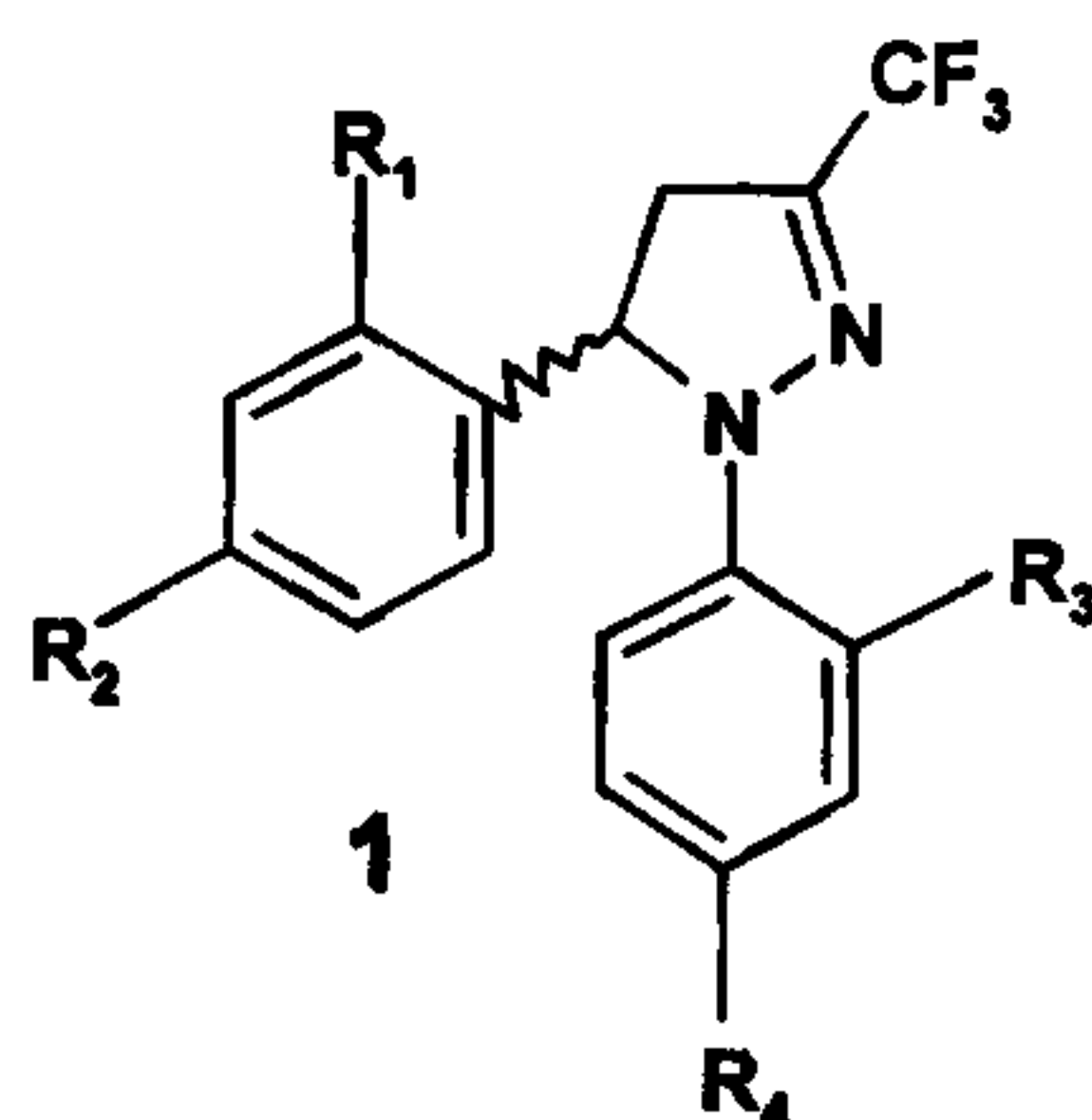
10 with a mixture of toluene and cyclohexane: pf= 86-9°;  $[\alpha]_{20}^D = -86,1$  (c=1, CH<sub>3</sub>OH); IR (KBr)  $\mu$  max (cm<sup>-1</sup>): 1598, 1513, 1416; <sup>1</sup>H-RMN (CDCl<sub>3</sub>)  $\delta$  (ppm): 7.87 (d, J= 8.4 Hz, 2H), 7.5-7.2 (m, 3H), 6.9-6.6 (m, 2H), 5.7 (dd, J= 6.5 Hz, J= 2.6 Hz, 1H), 3.8-3.6 (m, 1H), 3.2-2.9 (m, 1H), 3.02 (s, 3H).

27395-151

20

**CLAIMS:**

1. A process for preparing a racemic mixture ( $\pm$ )-1 of compounds having the general formula 1, enantiomerically pure compounds (-)-1 and (+)-1,



wherein

$R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy;

$R_2$  represents hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy, trifluoromethoxy, methylsulphonyl or aminosulphonyl;

$R_4$  represents hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy, trifluoromethoxy, methylsulphonyl or aminosulphonyl;

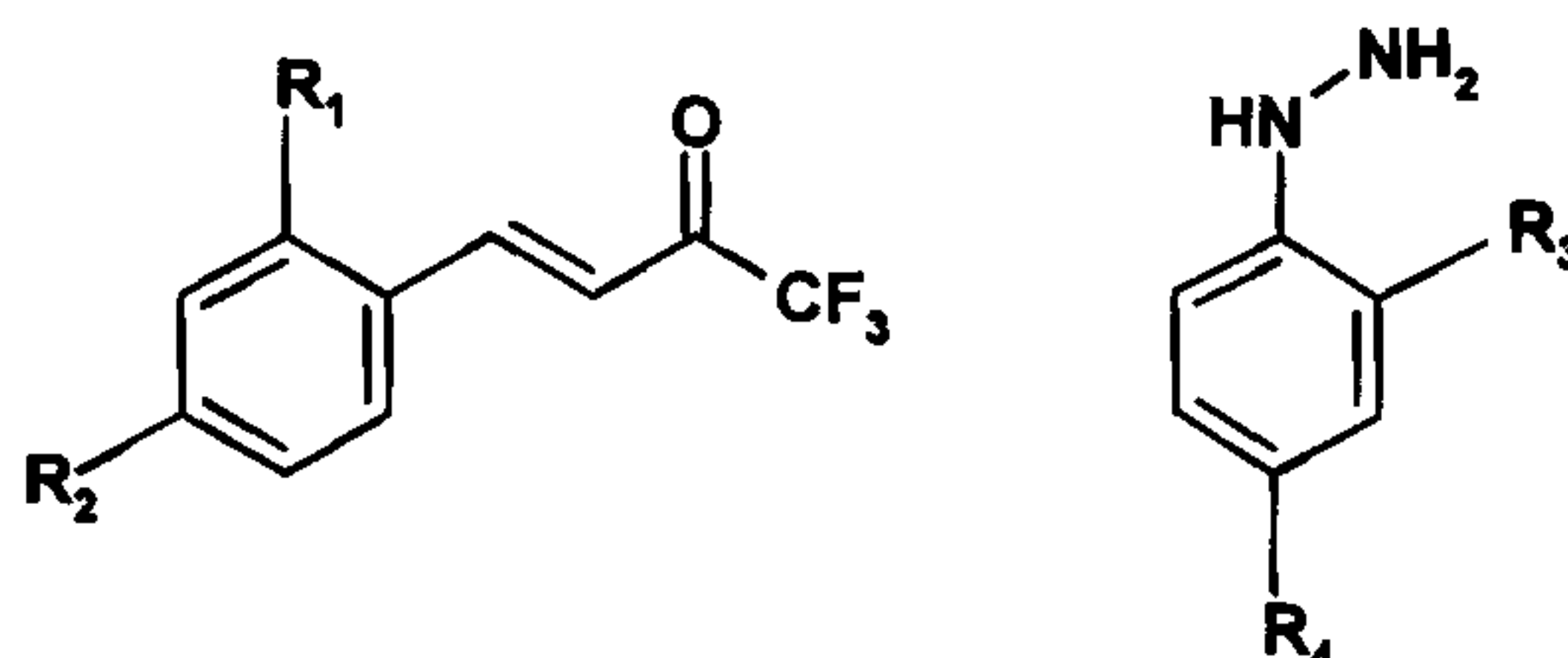
with the proviso that  $R_2$  or  $R_4$  is methylsulphonyl or aminosulphonyl;

wherein the process comprises:

a) preparing the racemic mixture with the general formula ( $\pm$ )-1 by reacting an (*E*)-1,1,1-trifluoro-4-aryl-3-buten-2-one with a phenylhydrazine, wherein  $R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy; and  $R_2$  and  $R_4$  represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy or trifluoromethoxy; with the proviso that at least one of  $R_2$  and  $R_4$  represents hydrogen

27395-151

21



to obtain a pyrazoline with the general formula ( $\pm$ )-1, wherein  $R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy; and  $R_2$  and  $R_4$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy or trifluoromethoxy; with the proviso that at least one of  $R_2$  and  $R_4$  represents hydrogen;

b) reacting the pyrazoline of a) with chlorosulphonic acid followed by reaction with sodium hydroxide to form the pyrazoline with the general formula ( $\pm$ )-1, wherein  $R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy; and  $R_2$  and  $R_4$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy, trifluoromethoxy or a sodium sulphonate group, with the proviso that one of  $R_2$  and  $R_4$  represents the sodium sulphonate group ( $\text{SO}_3\text{Na}$ );

c) reacting the pyrazoline of b) with thionyl chloride to form the pyrazoline with the general formula ( $\pm$ )-1, wherein  $R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy; and  $R_2$  and  $R_4$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy, trifluoromethoxy or sulphonyl chloride; with the proviso that one of  $R_2$  and  $R_4$  represents a sulphonyl chloride group ( $\text{SO}_2\text{Cl}$ );

d) reacting the pyrazoline of c) with ammonium carbonate or ammonia, or with sodium sulphite and methyl iodide or methyl sulphate to provide the racemic mixture with the general formula ( $\pm$ )-1 wherein  $R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy; and  $R_2$  and  $R_4$  independently represent hydrogen, chlorine, fluorine,

27395-151

22

methyl, trifluoromethyl, methoxy, trifluoromethoxy, methylsulphonyl or aminosulphonyl; with the proviso that one of  $R_2$  and  $R_4$  represents a methylsulphonyl group ( $\text{SO}_2\text{CH}_3$ ) or an aminosulphonyl group ( $\text{SO}_2\text{NH}_2$ ); and

e) optionally, after completion of step b), preparing the

5 enantiomerically pure compounds with the general formula 1 by resolving the racemic mixture of the pyrazoline of b) with the general formula ( $\pm$ )-1, into the enantiomers thereof by reaction with optically active ephedrine, followed by formation of the sodium salt of each enantiomer, reaction with thionyl chloride and ammonium carbonate or ammonia, or with thionyl chloride followed by sodium

10 sulphite and methyl iodide or methyl sulphate, to obtain separately the enantiomerically pure compounds with the general formula (-)-1 and (+)-1 wherein  $R_1$  and  $R_3$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl or methoxy; and  $R_2$  and  $R_4$  independently represent hydrogen, chlorine, fluorine, methyl, trifluoromethyl, methoxy, trifluoromethoxy,

15 methylsulphonyl or aminosulphonyl; with the proviso that one of  $R_2$  and  $R_4$  represents a methylsulphonyl group ( $\text{SO}_2\text{CH}_3$ ) or an aminosulphonyl group ( $\text{SO}_2\text{NH}_2$ ).

2. A process according to claim 1, wherein, in step a), the

(*E*)-1,1,1-trifluoro-4-aryl-3-buten-2-one is reacted with the phenylhydrazine in an

20 alcohol or in absence of a solvent, in an organic acid medium comprising acetic acid or p-toluensulphonic acid or in an inorganic acid comprising hydrochloric acid, or in an alkaline medium provided by piperidine, piperazine, sodium hydroxide, potassium hydroxide, sodium methoxide or sodium ethoxide at a temperature ranging between ambient temperature and  $150^\circ\text{C}$  for a time between

25 2 and 48 hours.

3. A process according to claim 2, wherein the alcohol is ethanol or isopropanol.

4. A process according to any one of claims 1 to 3, wherein, in step b), the pyrazoline with the general formula ( $\pm$ )-1 of a) is reacted with the

30 chlorosulphonic acid without a solvent or with a chlorinated solvent at a

27395-151

23

temperature between 0°C and 100°C, and afterwards reacting with the sodium hydroxide to form the pyrazoline with the general formula (±)-1 wherein one of R<sub>2</sub> and R<sub>4</sub> represents the sodium sulphonate group (SO<sub>3</sub>Na) and R<sub>1</sub>, R<sub>3</sub> and the other of R<sub>2</sub> and R<sub>4</sub> are as defined in claim 1.

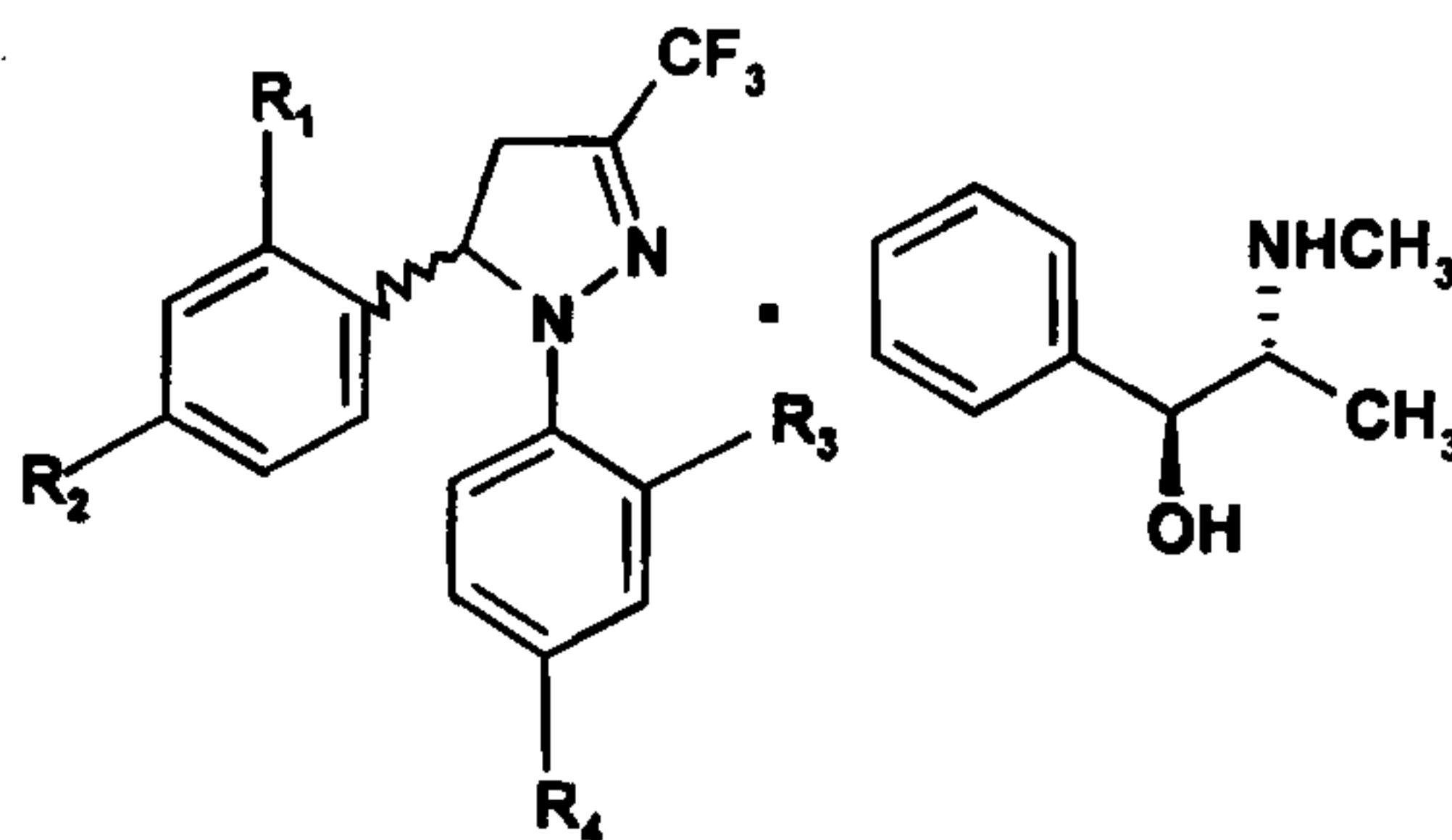
5 5. A process according to any one of claims 1 to 4, wherein, in step c), the pyrazoline with the general formula (±)-1 of step b) is reacted with the thionyl chloride in a solvent at a temperature between 40°C and reflux temperature for a time between 2 and 24 hours, and then, in step d), the product of step c) is  
10 reacted with the ammonium carbonate or the ammonia, or with thionyl chloride followed by the sodium sulphite and the methyl iodide or the methyl sulphate in toluene, methanol or water, at a temperature between 40°C and reflux temperature for a time between 1 and 12 hours, to form the pyrazoline with the general formula (±)-1 wherein one of R<sub>2</sub> and R<sub>4</sub> represents the methylsulphonyl group (SO<sub>2</sub>CH<sub>3</sub>) or the aminosulphonyl group (SO<sub>2</sub>NH<sub>2</sub>) and R<sub>1</sub>, R<sub>3</sub> and the other  
15 of R<sub>2</sub> and R<sub>4</sub> are as defined in claim 1.

6. A process according to claim 5, wherein the solvent of step c) is toluene.

7. A process according to claim 1, wherein the resolution of the racemic mixture (±)-1 of step b), by reaction with the (+)-ephedrine of step e)  
20 takes place in a solvent and the separation of the (-)-1 and (+)-1 enantiomers comprises crystallisation of diastereoisomeric salt (-)-1·(+)-ephedrine of (+)-1·(+)-ephedrine, wherein one of R<sub>2</sub> and R<sub>4</sub> represents a sulphonic acid group (SO<sub>3</sub>H) and R<sub>1</sub>, R<sub>3</sub> and the other of R<sub>2</sub> and R<sub>4</sub> are as defined in claim 1, and

27395-151

24



1·(+)-ephedrine

5  
10 separate formation of the sodium salts (-)-1 and (+)-1, in an aqueous medium or an alcohol comprising isopropyl alcohol, wherein one of R<sub>2</sub> and R<sub>4</sub> represents a sodium sulphonate group (SO<sub>3</sub>Na) and the R<sub>1</sub>, R<sub>3</sub> the other of R<sub>2</sub> and R<sub>4</sub> are as defined in claim 1; and then, in step d), reacting each enantiomer with the thionyl chloride and then with the ammonium carbonate or the ammonia, or instead with  
15 the thionyl chloride followed by the sodium sulphite and the methyl iodide or the methyl sulphate, to form separately the enantiomerically pure pyrazolines (-)-1 and (+)-1, wherein one of R<sub>2</sub> and R<sub>4</sub> represents the methylsulphonyl group (SO<sub>2</sub>CH<sub>3</sub>) or the aminosulphonyl group (SO<sub>2</sub>NH<sub>2</sub>) and R<sub>1</sub>, R<sub>3</sub> and the other of R<sub>2</sub> and R<sub>4</sub> are as defined in claim 1.

20 8. A process according to claim 7, wherein the solvent of step e) is chloroform or toluene.

9. A process according to claim 1, wherein the resolution of the racemic mixture (±)-1 of step b), by reaction with the (-)-ephedrine of step e) takes place in a solvent and the separation of the (-)-1 and (+)-1 enantiomers comprises  
25 crystallisation of diastereoisomeric salt (-)-1·(-)-ephedrine of (+)-1·(-)-ephedrine, wherein one of R<sub>2</sub> and R<sub>4</sub> represents a sulphonic acid group (SO<sub>3</sub>H) and R<sub>1</sub>, R<sub>3</sub> and the other of R<sub>2</sub> and R<sub>4</sub> are as defined in claim 1, and separate formation of the sodium salts (-)-1 and (+)-1, in an aqueous medium or in an alcohol comprising isopropyl alcohol, wherein one of R<sub>2</sub> and R<sub>4</sub> represents a  
30 sodium sulphonate group (SO<sub>3</sub>Na) and R<sub>1</sub>, R<sub>3</sub> and the other of R<sub>2</sub> and R<sub>4</sub> are as

27395-151

25

defined in claim 1, and then, in step d), reacting each enantiomer with the thionyl chloride and then with the ammonium carbonate or the ammonia, or with the thionyl chloride followed by the sodium sulphite and the methyl iodide or the methyl sulphate, to form separately the enantiomerically pure pyrazolines (-)-1 and  
5 (+)-1, wherein one of R<sub>2</sub> and R<sub>4</sub> represents the methylsulphonyl group (SO<sub>2</sub>CH<sub>3</sub>) or the aminosulphonyl group (SO<sub>2</sub>NH<sub>2</sub>) and R<sub>1</sub>, R<sub>3</sub> and the other of R<sub>2</sub> and R<sub>4</sub> are as defined in claim 1.

10. A process according to claim 9, wherein the solvent of step e) is chloroform or toluene.

FETHERSTONHAUGH & CO.

OTTAWA, CANADA

PATENT AGENTS

